STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

REPORTS OF THE
DIVISION OF ENGINEERING AND IRRIGATION
EDWARD HYATT, State Engineer

BULLETIN No. 20

REPORT

on

KENNETT RESERVOIR DEVELOPMENT

An Analysis of Methods and Extent of Financing by Electric Power Revenue

By LESTER S. READY, Consulting Engineer

A Report to the Joint Legislative Committee
of 1927 on Water Resources

CALIFORNIA STATE PRINTING OFFICE
SACRAMENTO, 1929

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BULLETIN No. 80

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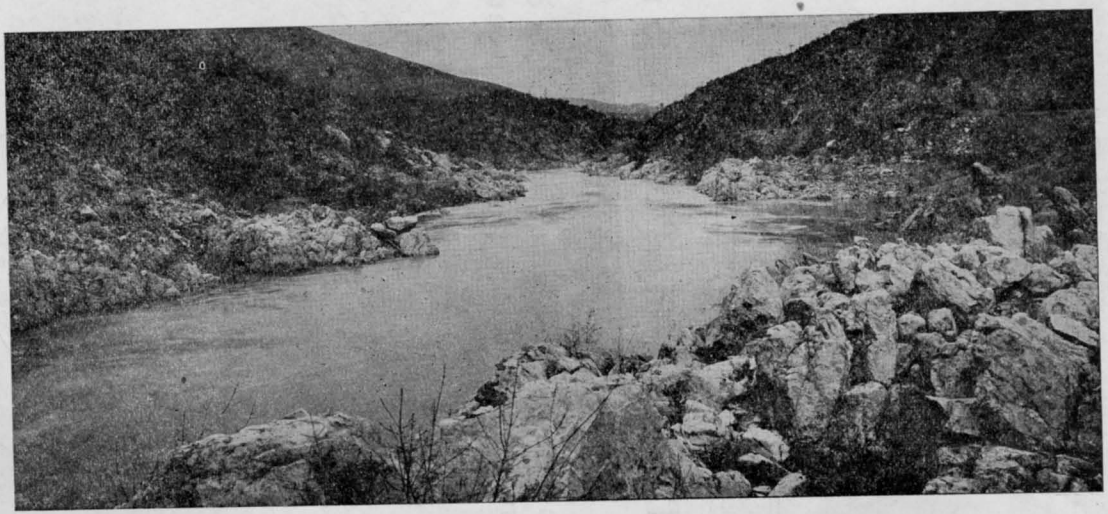

Kennett Dam Site in Sacramento Canyon

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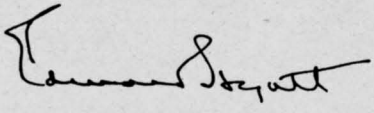
MR. B. S. CRITTENDEN, Chairman,
Joint Legislative Committee on Water Resources,
Tracy, California.

SUBJECT: WATER RESOURCES INVESTIGATION

SIR: In accordance with request of your committee there has been prepared and is being transmitted herewith, a report on certain phases of the Kennett reservoir, a unit of the "Coordinated Plan" for the development of the water resources of California. This report, prepared under the direction of Mr. Lester S. Ready, consulting engineer, deals particularly with the method and extent of financing this unit by revenues from electric power and is based upon estimates set forth in Bulletin No. 13 entitled "The Development of the Upper Sacramento River," published by this Division.

In the preparation of Bulletin No. 13, the basic consideration under the statute (chapter 477, Statutes of 1925) directing such report, was that of maximum utilization of the water resources of the State. The electric power installation was determined in accord with this mandate. In the following report, however, the consideration is one of economic immediate installation from present commercial viewpoint. Therefore, the conclusions of Bulletin No. 13 have been altered somewhat in this respect. The exact desirable installation can not be accurately stated until the manner of the disposition of the power is known. Whatever size is decided upon, provision should be made for future enlargement to that described in Bulletin No. 13, so that the maximum use of the water resources may be utilized.

Very truly yours,



State Engineer.

Sacramento, California, January 4, 1929.

LETTER OF TRANSMITTAL, AUTHOR TO STATE ENGINEER

MR. EDWARD HYATT,
State Engineer,
Sacramento, California.

SIR: Submitted herewith is a report on "Kennett Reservoir Development, an Analysis of Methods and Extent of Financing by Electric Power Revenue," prepared in compliance with your request.

Although the analysis and conclusions are set forth in fairly concise manner in the report, matters of outstanding importance are summarized in this letter.

SUBJECT OF REPORT.

The Kennett reservoir was selected from several considered in the "Coordinated Plan" of water development in the Sacramento and San Joaquin valleys as being one of the principal units in that plan and in many respects typical of the various units. The analysis made, data submitted and deductions set forth will be applicable in general to other units of the plan with modifications, however, for operating characteristics and geographic location.

The specific Kennett development considered was that contemplating a 420-foot dam, a 2,940,000 acre-foot reservoir and a power plant of 275,000 kilovolt-amperes (220,000 kilowatts) capacity, costing in total $70,000,000. The figures for the power plant capacity and total cost differ from those under Bulletin No. 13, "The Development of the Upper Sacramento River," issued by Division of Engineering and Irrigation, where they are given as 400,000 kilovolt-amperes and $80,000,000, respectively. The power plant capacity was reduced to 275,000 kilovolt-amperes after a study of power values revealed that the latter was the more economic commercial installation under present conditions. The difference in cost is due to this change and to a reduction of interest rate during construction, from 6 per cent to 4.5 per cent.

The development has been analyzed as suggested by you, based upon the operation of the reservoir coordinately for:

1. Control of salinity to Antioch in the delta of the Sacramento and San Joaquin rivers.
2. Control of floods on the Sacramento River to 125,000 second-feet maximum, measured at Red Bluff.
3. An irrigation supply for San Joaquin Valley (330,000 acre-feet per season; 1000 second-feet maximum rate of flow) and additional water for Sacramento Valley.
4. Generation of power consistent with the primary uses of the reservoir as above set forth.

Five plans of financing suggested have been studied, the plans being:

1. Reservoir, dam and power plant financed and operated by private capital.
2. Reservoir and dam financed and operated by the state; power plant financed and operated by private capital; use of water for

power generation sold by State to private interests financing the power plant.

3. Reservoir, dam and power plant financed and operated by State; the power output wholesaled at the power plant.

4. Reservoir, dam and power plant and main trunk transmission lines to important load centers in northern California, financed and operated by the State; power wholesaled at substations to political subdivisions and privately-owned public utilities.

5. Reservoir, dam and power plant, main trunk transmission lines and substations, steam standby plants and general secondary transmission and distribution systems financed and operated by the State; power retailed to the general public.

In each of these plans the State is to retain control of the operations of the dam and reservoir in so far as it affects release of water for salinity or flood control and irrigation supply.

CONCLUSIONS FROM INVESTIGATION.

Ability of the market to absorb Kennett output.

1. The power market tributary to the Kennett development is that existing generally north of Stanislaus County within a distance of approximately 300 miles of Kennett.

2. This market required the production in 1927 of 3,219,000,000 kilowatt hours, and by 1936, the earliest that Kennett may be expected to be completed, will require approximately 5,328,000,000 kilowatt hours annually.

3. Over 65 per cent of the tributary power market is located within 50 miles radius of San Francisco.

4. The tributary market at present is served through two main systems; one including the Pacific Gas and Electric Company and connecting companies supplying 75 per cent; the other, the Great Western Power Company of California supplying 25 per cent of the requirements.

5. The average annual power output of Kennett based upon a plant installation of 275,000 kilovolt-amperes is estimated at 1,217,000,000 kilowatt hours, varying from 990,000,000 to 1,314,000,000 kilowatt hours.

6. The present development of power in northern California is almost entirely from hydro-electric plants, steam-electric plants being used for standby purposes primarily. A greater proportion of the energy required should be developed by steam-electric plants before Kennett is completed.

7. The output of Kennett represents the growth of load for the entire northern market for 4 years. Approximately 5¼ years would be required for the growth of load on the system of the Pacific Gas and Electric Company and connecting companies to absorb the entire output.

8. With coordination of future developments between the State and the existing agencies, the growth in load prior to the completion of Kennett could be carried by steam-electric plants, thus materially reducing the burden of absorption of Kennett output.

9. With reasonable cooperation between the State and the existing agencies, absorption of Kennett output will present no serious diffi-

culties under Plans 1, 2, 3 and 4. The existing utilities have met problems relatively greater than the absorption of the output of Kennett presents. The Pacific Gas and Electric Company in 1925 brought in its own Pit No. 3 plant and took delivery from the City of San Francisco and the California-Oregon Power Company, a total representing over 40 per cent of its then existing load. This compares with Kennett output which represents approximately 25 per cent of the load that would be tributary in 1936. A similar condition was met by the Great Western Power Company in 1921.

Cost of Kennett Development

The estimated cost of Kennett reservoir, dam and power plant is:

Land and improvements flooded	$22,882,000
Dam	30,118,000
Total	$53,000,000
Power plant	17,000,000
Total	$70,000,000

The annual cost of Kennett reservoir, dam and power plant, which is set forth in detail for Plans 1, 2 and 3, varies depending upon the basis of treatment of taxes on private capital and amortization of State bonds. The limits of the estimated costs are as follows:

	Total	*Mills per kwh. of output*
Plan 1. Complete private ownership:		
(a) Including state taxes	$6,867,000	5.64
(b) Excluding state taxes	6,231,000	5.12
Plan 2. State ownership of reservoir and private ownership of power plant:		
(a) With 40-year straight line amortization of state bonds and state taxes on private capital	5,983,000	4.91
(b) With 40-year sinking fund amortization of state bonds and state taxes excluded	4,985,000	4.09
Plans 3, 4 and 5. State ownership:		
(a) With 40 year straight line amortization of bonds	5,668,000	4.66
(b) With 40-year sinking fund amortization of bonds	4,652,000	3.82
(c) Excluding bond amortization	3,918,000	3.22

Plan 4 will require additional capital for transmission lines and substations by the State, amounting as a minimum to $9,600,000. The added cost assuming wholesaling of power to the main utilities at a point near the center of load based on 4 per cent sinking fund amortization is estimated at $784,000 per annum.

Value of power.

The value of power delivered from Kennett power plant to transmission as indicated by the cost of power from other hydro-electric plants is from 2.7 to 3.3 mills per kilowatt hour of power plant output; as indicated by steam power development, the value is from 3.45 to 3.68 mills per kilowatt hour; and as indicated from comparison with existing contracts, approximately 3.45 mills per kilowatt hour.

Revenue from power.

The revenue that may be obtained from the sale of power output at Kennett plant may not be expected to exceed $4,250,000 per annum, and at the terminal of transmission near the Bay district, not to exceed $5,300,000, or approximately 3.5 and 5 mills per kilowatt hour delivered, respectively. Under complete control and operation of Kennett reservoir for irrigation the value of power output will be reduced to approximately $2,000,000 per annum based upon plant delivery.

Plan 5.

Plan 5, contemplating distribution of the total power output by the State, will require duplication of existing systems or condemnation of at least one-quarter of the distribution systems of northern California and the added capital expenditure of over $110,000,000.

It is doubtful if this action would assist the State in the carrying of the costs of Kennett development beyond which would be possible under Plan 3 or 4.

Other revenue required.

By comparison of the cost of Kennett with the revenue from power at the plant of $4,250,000, or to substation delivery of $5,300,000, probable maximum, it is apparent that power can not carry much more than the cost of interest, depreciation and operating expenses of Kennett even under State development. Other sources of revenue such as State or Federal aid, sale of water for irrigation or payments by other beneficiaries would be needed to cover the full amortization requirements of State bonds. The amount of aid required would be minimized by extending the amortization period of State bonds beyond the period of forty years assumed in this report.

Very truly yours,

Leslie A. Ready

Consulting Engineer.

San Francisco, California, October 23, 1928.

ENGINEERING ADVISORY COMMITTEE

This bulletin has been prepared in consultation with a committee of engineers, who advised in the preparation of the "Coordinated Plan" for the development of the water resources of California. The members of this committee are:

Louis C. Hill
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H. A. VanNorman
Paul Bailey
A. J. Cleary
G. A. Elliott
B. A. Etcheverry
F. C. Herrmann
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A. Kempkey

Cooperating with Committee:

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District Engineer, U. S. Forest Service representing the Federal Power Commission in California

A. V. Guillou
Assistant Chief Engineer, State Railroad Commission

T. H. Emerson
Major, Corps of Engineers, U. S. Army, member and Secretary of California Debris Commission

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ORGANIZATION

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EDWARD HYATT, *State Engineer*

This bulletin has been prepared by

LESTER S. READY, *Consulting Engineer,*

assisted by the following members of the staff of the Division of Engineering and Irrigation:

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JOS. T. MAGUIRE
E. N. SAWTELLE

REPORT ON

Kennett Reservoir Development

An Analysis of Methods and Extent of Financing by Electric Power Revenue

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AUTHORITY FOR REPORT.

This report is prepared in compliance with request of Mr. Edward Hyatt, State Engineer, and of the Joint Legislative Committee on Water Resources for the State of California, that a study and analysis be made of the financial and economic phases of the proposed Kennett reservoir.

SUBJECT OF REPORT.

The "Coordinated Plan" for water development in the Sacramento and San Joaquin valleys contemplates several large reservoirs for the storage of water for flood and salinity control and irrigation. Considerable electric power can be developed incidental to and in connection with these reservoirs. The Kennett reservoir has been selected for analysis as being one of the principal units of the "Coordinated Plan," and typical in many respects of the several units of this plan. The analysis made, data submitted and deductions set forth will in general be applicable to the other units of the plan with modifications, however, for operating characeristics and geographic location.

This study and report deals with the relative value of several plans of financing the Kennett unit. and the extent to which it can be financed by revenue from electric power that can be generated at the dam.

The analysis is based on the operation of the reservoir coordinately for:

1. Control of salinity to Antioch in the delta of the Sacramento and San Joaquin rivers.
2. Control of floods on Sacramento River to 125,000 second-feet maximum, measured at Red Bluff.
3. Irrigation supply for San Joaquin Valley (330,000 acre-feet per season: 1000 second-feet maximum rate of flow) and additional water for Sacramento Valley.
4. Generation of power consistent with the primary uses of the reservoir as above set forth.

Although the primary purposes of this reservoir are for flood and salinity control and irrigation, the requirements for irrigation during the early period of use, apparently, will not seriously interfere with the power output, which will be relatively large. Therefore, an important element to be considered in connection with the financial analysis is the value of the power output and the extent to which it may carry the financial burden of the development.

Five different plans for the financing of the development have been suggested for special consideration. In each plan the State is to retain control of the operation of the dam and reservoir in so far as it affects

the release of water for salinity control, flood control and irrigation supply for San Joaquin Valley.

The five plans suggested are:

1. Reservoir, dam and power plant financed and operated by private interests.
2. Reservoir and dam financed and operated by the State. Power plant financed and operated by private interests; use of water for power generation sold by State to private interests financing the power plant.
3. Reservoir, dam and power plant financed and operated by State; power output wholesaled at the power plant.
4. Reservoir, dam and power plant, and main trunk transmission lines to important load centers in northern California financed and operated by the State. Power wholesaled at substations to political subdivisions and privately-owned public utilities.
5. Reservoir, dam and power plant, main trunk transmission lines and substations, steam-electric standby plants and general secondary transmission and distribution systems financed and operated by the State. Power retailed to general public.

A modification of Plan 3, considered herein as Plan 3a, has also been suggested. This plan contemplates the disposition of part of the power at the power plant by sale to municipalities and resale companies. It is suggested that the large private power company or companies purchasing the bulk of the power be required under contract to act as common carriers transmitting the power for compensation from the power plant to the respective municipalities or resale companies.

The general benefits to central and northern California resulting from irrigation, flood control and salinity control, and to San Joaquin Valley for irrigation, are not considered in this report, the report being limited primarily to an analysis of the financial, economic and engineering phases of the development as affected by the disposition of power which may be produced.

SCOPE OF INVESTIGATION.

The investigation carried on in connection with this report has consisted of a study and analysis of the Kennett development with reference to annual cost, potential output and characteristics of the power to be produced, both when operated as suggested and when ultimately operated primarily for irrigation demands. This latter condition must be given some consideration in order that a clear perspective of the future financial situation may be obtained.

Study and analysis of the power market tributary to Kennett and the present and future ability of the market to absorb the output under the different plans presented have been made. The value of the power output has been determined from study of cost of power from other sources, both steam-electric and hydro-electric, and the price for power as indicated by wholesale purchase contracts. The probable power revenue to be obtained from Kennett has been estimated. An independent check of the estimated cost of Kennett development as set forth in Bulletin No. 13, "The Development of the Upper Sacramento River," issued by Division of Engineering and Irrigation, has not been

made. The estimate therein has been revised, however, in two particulars. The interest rate has been reduced to the basis of State financing. The size of the power plant has been reduced from 400,000 kilovolt-amperes (the figure used in Bulletin No. 13) to 275,000 kilovolt-amperes. The latter size would appear the more economical development, for the potential power output as viewed from the standpoint of present and probable future cost of power. The basic considerations, in the preparation of Bulletin No. 13, were that of maximum utilization of the water resources of the State rather than the most economic power development considered herein. No detailed layout of a system for complete distribution of power output of Kennett has been made. This matter has been analyzed from a broad consideration of the problem and the determining factors involved.

COOPERATION.

In connection with the investigation and preparation of this report, I have had the full assistance of the engineers of the State Division of Engineering and Irrigation under the direction of Mr. A. D. Edmonston, and the cooperation of the Railroad Commission of the State of California and its engineering department; also of Mr. F. E. Bonner of the Federal Power Commission, and the power companies and municipal electric utilities. I wish to express herein my appreciation of the assistance received.

PROPOSED KENNETT DEVELOPMENT.

The Kennett dam and reservoir as contemplated in Bulletin No. 13 is to be located on the Sacramento River near Kennett, Shasta County, approximately two hundred miles due north of San Francisco. The development includes a dam, 420 feet in height, a reservoir of 2,940,000 acre-feet capacity and a power plant of 275,000 kilovolt-amperes capacity with a potential output of 1,217,600,000 kilowatt hours annually. The reservoir will flood 23,000 acres of land. The main line of the Southern Pacific Company and a portion of the State highway will have to be relocated. The estimated cost of the development, including the dam, reservoir, flood control features and power plant, is $70,000,000. This estimate of cost includes interest during construction on basis of State financing. Though under private development interest rates would be higher, the analysis for clarity has been based upon equal capital cost, the difference being within the accuracy of the estimate.

The above covers the development as outlined in Bulletin No. 13, except as to change in power plant capacity, and is the development contemplated in Plans 1, 2 and 3 listed herein. Under Plan 4, State construction of a 220,000-volt transmission line would be added, and, under Plan 5, extensive purchase of existing electric transmission and distribution systems or duplication thereof would be necessary to dispose of the power.

IMPORTANT QUESTIONS INVOLVED.

Following are certain of the important features to be considered in the analysis:

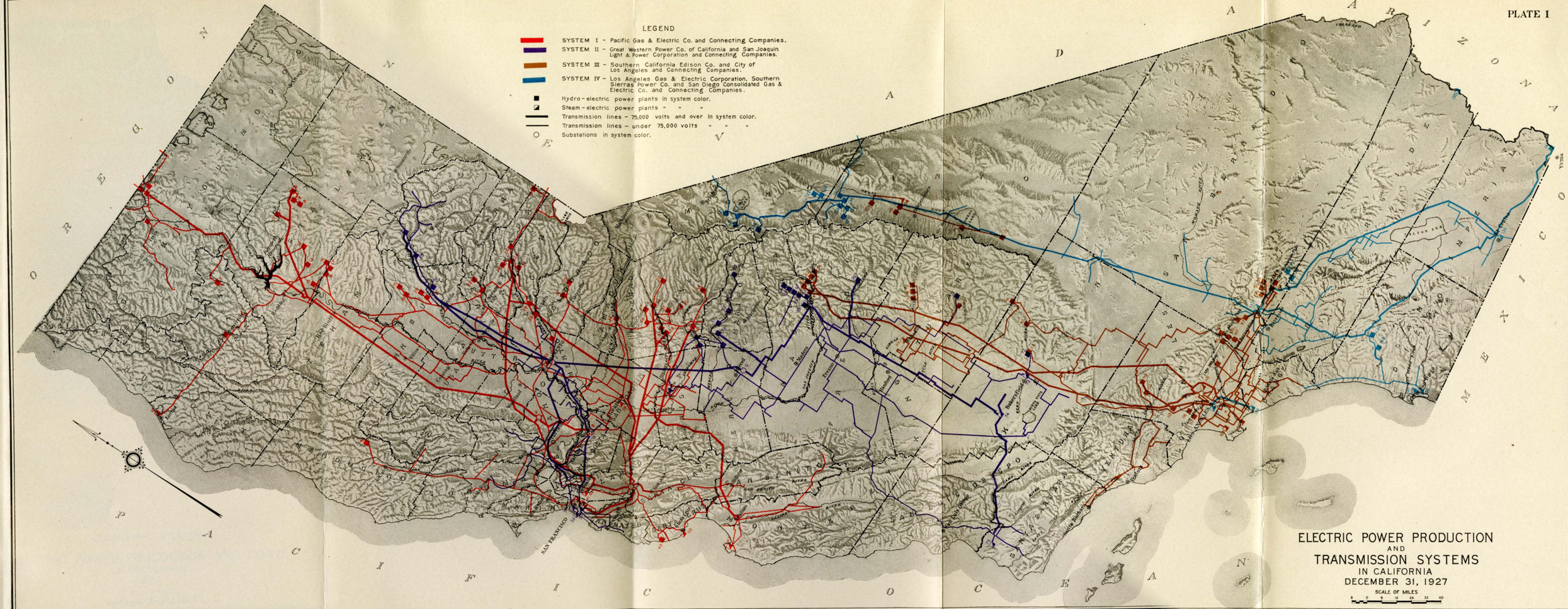
1. The ability of the electric power market to absorb the output of the development when completed.
2. The investment and annual cost of the development under the several plans proposed.

3. The value of power and the amount of revenue from power which may be obtained by the sale of the output of the Kennett development.

4. The effect of the ultimate operation of the reservoir primarily for irrigation on the value of power output.

The first four of the five proposed plans of financing Kennett involve in general the same conditions with reference to the ability of the market to absorb the power output. The power would be delivered to the main existing agencies. Investment costs would be practically the same in total and the annual costs and revenues are subject to definite comparisons. The fifth plan contemplates a material departure from the other four and would be subject to special and separate consideration.

PLATE I



ELECTRIC POWER PRODUCTION AND TRANSMISSION SYSTEMS IN CALIFORNIA DECEMBER 31, 1927

SCALE OF MILES

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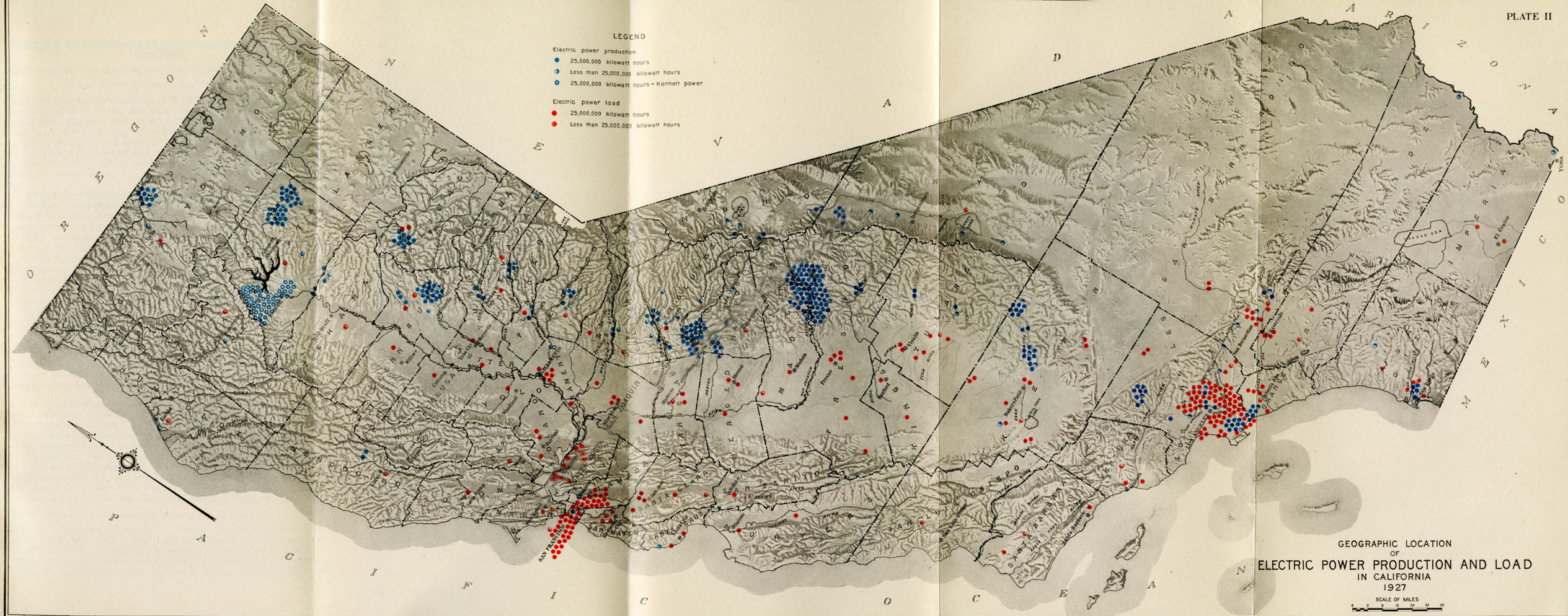
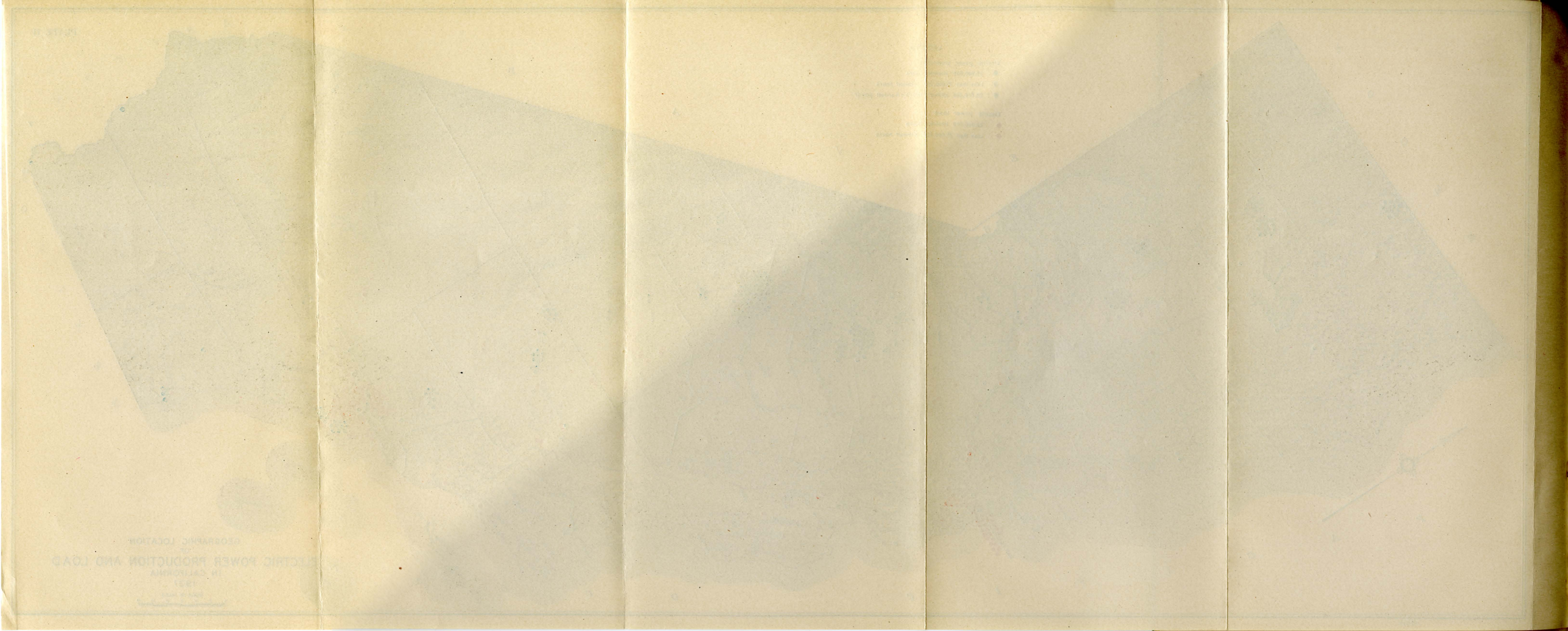
PLATE 1

PLATE II



GEOGRAPHIC LOCATION
OF
ELECTRIC POWER PRODUCTION AND LOAD
IN CALIFORNIA
1927

62689



ABILITY OF POWER MARKET TO ABSORB OUTPUT OF KENNETT

DESCRIPTION OF PRESENT POWER DEVELOPMENTS OF THE STATE

A. Extent and grouping of systems

The electric power development of the state has experienced a rapid and steady growth during the past twenty-five years. During this period, interconnections and consolidations have occurred until at the present time, the supplying of electric power is through four main networks or groupings of systems. These are set forth on Plate I, "Electric Power Production and Transmission Systems in California, December 31, 1927," which shows the location of the hydro-electric and steam-electric plants and the main transmission systems in the State:

System I—Includes Pacific Gas and Electric Company and its subsidiary companies; The California-Oregon Power Company; Snow Mountain Water and Power Company; City of San Francisco and Coast Counties Gas and Electric Company.

This network, extending from the northern boundary of the State to the Salinas Valley, represents the largest northern system and has transmission lines nearest Kennett.

System II—Includes Great Western Power Company of California and its allied companies, San Joaquin Light and Power Corporation and Midland Counties Public Service Corporation; also the Modesto and Turlock Irrigation Districts and the Merced Irrigation District.

System III—Consists mainly of the Southern California Edison Company, the City of Los Angeles and the City of Pasadena.

System IV—Includes Southern Sierras Power Company, Los Angeles Gas and Electric Corporation, and San Diego Consolidated Gas and Electric Company, operating in the southern and eastern portions of the State, which, although not fully connected at this time, will be a connected system within the near future.

It is to be noted that System I is nearest in distance to the Kennett reservoir, which is shown in "black" on Plate I. System II is somewhat further south, although the Great Western Power Company serves a territory generally the same as that served by the Pacific Gas and Electric Company and its connecting companies. Systems III and IV serve the southern part of the State, the market supplied being from 456 to 600 miles from Kennett. This distance is such that from an economic standpoint the market served by these companies is not available to absorb the power from Kennett. This is also largely true of the market served by the San Joaquin Light and Power Corporation.

B. Extent and distribution of present load or power market

Plate II, "Geographic Location of Electric Power Production and Load in California, 1927," sets forth graphically the location and extent of the power production and market throughout the State for the year 1927 as indicated by existing utility power plant and substation outputs, respectively. The magnitude of the production by dis-

tricts or groups of plants and the load by counties is indicated by "dots." Each "full dot" represents 25,000,000 kilowatt hours and each "half dot" an amount less than 25,000,000 kilowatt hours annual output. The potential output of Kennett is also delineated. This plate indicates where kilowatt hours were produced and where used in 1927. It does not show the extent of plant capacities. It is to be noted that the main location of power production is along the Sierra Nevada Mountains from the California-Oregon line to the Kern River, the larger developments being on the Pit, Feather, Tuolumne and San Joaquin rivers. Plates I and II together indicate the general transmission of power southward from the power plants in the Sierra Nevadas to the power load which centers around San Francisco Bay for northern California, and Los Angeles for southern California, with general but much less dense use throughout the Sacramento and San Joaquin valleys. Study of Plate II and the data supporting it indicates that in excess of 65 per cent of the power market of northern California is within a radius of fifty miles of San Francisco; also a like percentage for southern California is located within the same radius of Los Angeles.

DIVISION OF POWER MARKET AND SYSTEMS FOR STUDY OF PROBLEM.

A general study of the sources of power in the State, the systems and the market indicates that for this analysis, the State should be divided into a northern district, comprising generally that portion served by System I and the Great Western Power Company of System II, hereafter referred to as "Northern Group," and a southern district. The southern district comprises that portion of the State generally south of Stanislaus County and served by San Joaquin Light and Power Corporation of System II, and System III and System IV, referred to as "Southern Group."

The two districts or groups are connected for interchange of power by the transmission line between the Great Western Power Company and the San Joaquin Light and Power Corporation. This tie-line is available for the shifting of power between the two sections of the State.

Table 1 sets forth by companies the production of power in millions of kilowatt hours and in per cent of the total for the northern and southern groups, respectively. There is also set forth by companies the total substation output in millions of kilowatt hours and in per cent of the totals for the respective groups, eliminating intercompany deliveries. This represents, measured in substation output, the power market served directly by the respective companies.

Table 1 also shows for the Northern Group that System I produced 79 per cent and served directly 75.2 per cent of the entire load in the Northern District; for the Southern Group, the San Joaquin portion of System II produced 18.2 per cent; System III, 66.5 per cent; and System IV, 15.3 per cent of the total power requirements of the Southern District. The San Joaquin system directly serves 16.3 per cent; System III, 67.6 per cent; and System IV, 16.1 per cent of the market of the Southern District.

TABLE 1

Electric Power Production and Substation Delivery by Companies, 1927

Name of company	Production		Substation delivery	
	Millions of kilowatt hours	Per cent of total	Millions of kilowatt hours	Per cent of total
NORTHERN GROUP.				
System I.				
California-Oregon Power Co.	290.3	9.0	24.2	0.9
Pacific Gas and Electric Company and its subsidiary companies	1,624.6	50.5	1,876.5	72.2
City of San Francisco	538.4	16.7	0	0
Snow Mountain Water and Power Co.	53.0	1.7	11.9	0.5
Utica Mining Co.	19.0	0.6	----	---
Coast Counties Gas and Electric Company	4.2	0.1	36.7	1.4
Melones Mining Company	4.7	0.1	0	0
West Side Lumber Company	1.6	0.1	----	---
Truckee River Power Co.	7.6	0.2	4.1	0.2
Total, System I	2,543.6	79.0	1,953.4	75.2
System II-a.				
Great Western Power Co. of California	675.4	21.0	645.6	24.8
Total, northern group	3,219.0	100.0	2,599.0	100.0
SOUTHERN GROUP.				
System II-b.				
San Joaquin Light and Power Corporation	504.4	12.4	515.2	15.0
Merced Irrigation District	126.6	3.1	0	0
Turlock-Modesto Irrigation Districts	104.3	2.5	43.7	1.3
U. S. National Park Service	7.7	0.2	----	---
Total, System II-b	743.0	18.2	558.9	16.3
System III.				
Southern California Edison Company	2,419.5	59.1	1,711.6	49.7
City of Los Angeles	268.8	6.6	567.9	16.5
City of Pasadena	31.6	0.8	49.4	1.4
Total, System III	2,719.9	66.5	2,328.9	67.6
System IV.				
Los Angeles Gas and Electric Corporation	247.1	6.0	247.2	7.2
Southern Sierras Power Co.	265.1	6.5	178.1	5.2
San Diego Consolidated Gas and Electric Co.	109.9	2.7	126.8	3.7
Yuma Project—United States Reclamation Service	5.2	0.1	----	---
Total, System IV	627.3	15.3	552.1	16.1
Total, southern group	4,090.2	100.0	3,439.9	100.0
Northern group	3,219.0	44	2,599.0	43
Southern group	4,090.2	56	3,439.8	57
Grand total, entire State	7,309.2	100	6,038.8	100

The following table summarizes for the state the distribution of production and load among the four systems:

Electric Production and Load in California, 1927

	Millions of kilowatt hours output		Per cent of total	
	Production	Substation output	Production	Substation output
System I	2543.6	1953.3	34.8	32.3
System II-a	675.4	645.6	9.2	10.7
Total, northern group	3219.0	2599.0	44.0	43.0
System II-b	743.0	558.9	10.2	9.3
System III	2719.9	2328.9	37.2	38.6
System IV	627.3	552.1	8.6	9.1
Total, southern group	4090.2	3439.9	100.0	100.0
Total State	7309.2	6038.8	56.0	57 0

DISTRIBUTION OF POWER MARKET BY COUNTIES.

Tables 2, 3-A and 3-B, and Plate III, "Distribution of Electric Power Load by Counties in California, 1927," set forth by counties the distribution of the power load throughout the State. These, together with Plate II, indicate for the market of northern California that 13.8 per cent of the market is located north of Sacramento County; 18.8 per cent in the counties surrounding Sacramento, including the mountain counties as far south as Tuolumne County; 62.7 per cent in the Bay counties; and 4.7 per cent in the counties south of Santa Clara County. The total substation output of this entire part of the State for 1927 was somewhat in excess of twice the potential development of Kennett.

TABLE 2

California Electric Power Load or Market by Counties Measured by Substation Delivery, 1927

County	*Substation delivery, thousands of kilowatt hours*	County	*Substation delivery, thousands of kilowatt hours*
Alameda	449,920	Orange	138,361
Alpine	------	Placer	19,858
Amador	22,846	Plumas	31,523
Butte	35,516	Riverside	132,809
Calaveras	12,802	Sacramento	172,146
Colusa	20,175	San Benito	20,823
Contra Costa	244,397	San Bernardino	239,016
Del Norte	------	San Diego	126,801
El Dorado	2,449	San Francisco	685,775
Fresno	171,885	San Joaquin	123,287
Glenn	21,161	San Luis Obispo	16,423
Humboldt	14,451	San Mateo	91,031
Imperial	40,257	Santa Barbara	57,766
Inyo	8,188	Santa Clara	131,575
Kern	256,869	Santa Cruz	50,591
Kings	43,863	Shasta	16,162
Lake	------	Sierra	------
Lassen	------	Siskiyou	20,584
Los Angeles	1,859,426	Solano	68,792
Madera	33,457	Sonoma	24,306
Marin	32,073	Stanislaus	67,451
Mariposa	3,000	Sutter	22,236
Mendocino	5,535	Tehama	8,351
Merced	69,341	Trinity	6,899
Modoc	------	Tulare	157,694
Mono	------	Tuolumne	18,824
Monterey	50,271	Ventura	56,814
Napa	4,884	Yolo	21,683
Nevada	33,901	Yuba	52,313
Total—Substation delivery by counties			6,016,561
Not segregated—Southern California Edison Co., interdepartmental			22,295
Entire State			6,038,856

GROWTH OF POWER LOAD.

Plate IV, "Electric Power Installation in California, 1911–1927," sets forth for the northern and southern groups and for the entire State, the growth in power developed by plant capacities, both hydro-electric and steam-electric, for the period 1911 to 1927. It is to be noted that in the Northern Group, up to the present time, the amount of hydro-electric capacity in per cent of total is considerably greater than in the Southern Group. Table 4 sets forth statistically the data indicated in Plate IV.

Plate V, "Electric Power Production in California, 1913–1927," presents for the period 1913 to 1927 and for the two groups and the State, the power output by months in thousands of kilowatts (average) for steam-electric and hydro-electric plants, respectively. The fluctuation in steam-electric production should be noted, as the amount is an important factor in the absorption of new hydro-electric developments.

This fluctuation has occurred partly on account of variation of hydro-electric power production between wet and dry years and partly as a result of the bringing in of new hydro-electric plants. The heavy demand for steam-electric power as a result of the 1924 drought is clearly indicated. The material reduction in steam-electric power in the northern part of the State in the past three years has been the result mainly of bringing in three large hydro-electric projects in 1925; Copco No. 2 of The California-Oregon Power Company, Pit No. 3 of the Pacific Gas and Electric Company, and Moccasin Creek plant of the City of San Francisco. The result of bringing in these three developments, having an annual output of approximately 1,000,000,000 kilowatt hours, has been to reduce the steam-electric power production to less than 1 per cent of the total and to create a condition of temporary oversupply.

TABLE 3-A

Substation Delivery by Counties Grouped Geographically
(District Served by Northern Group of Companies)

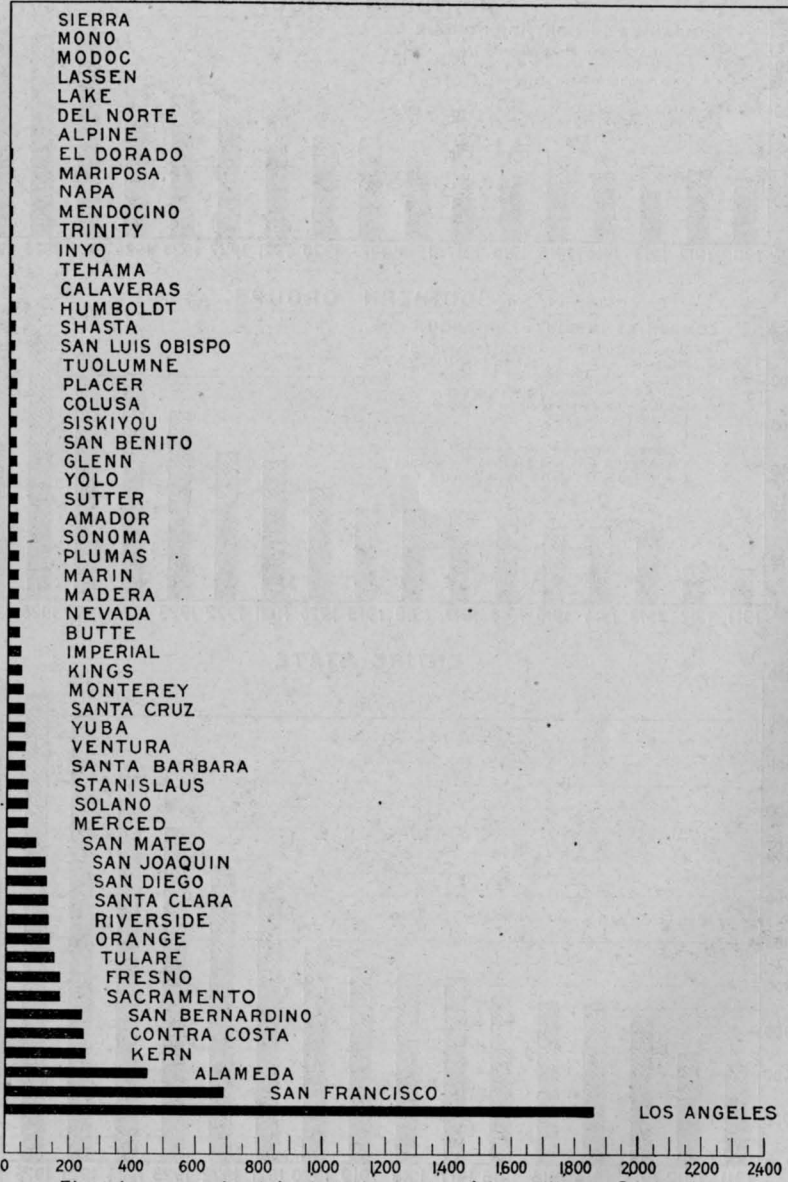
County	*Substation delivery* *Thousands of kilowatt hours*	*Per cent of total northern group*
DISTRICT 1.		
Butte	35,516	
Colusa	20,175	
Del Norte	-----	
Glenn	21,161	
Humboldt	14,451	
Lake	-----	
Lassen	-----	
Mendocino	5,535	
Modoc	-----	
Napa	4,884	
Nevada	33,901	
Placer	19,858	
Plumas	31,523	
Shasta	16,162	
Sierra	-----	
Siskiyou	20,584	
Sonoma	24,306	
Sutter	22,236	
Tehama	8,351	
Trinity	6,899	
Yolo	21,683	
Yuba	52,313	
Total, District 1	359,538	13.8
DISTRICT 2.		
Alpine	-----	
Amador	22,846	
Calaveras	12,802	
El Dorado	2,449	
Sacramento	172,146	
San Joaquin	123,287	
Solano	68,792	
Stanislaus	67,451	
Tuolumne	18,824	
Total, District 2	488,597	18.8
DISTRICT 3.		
Alameda	449,920	
Contra Costa	244,397	
Marin	32,073	
Santa Clara	131,575	
San Francisco	685,775	
San Mateo	91,031	
Total, District 3	1,634,771	62.7
DISTRICT 4.		
Monterey	50,271	
San Benito	20,823	
Santa Cruz	50,591	
Total, District 4	121,685	4.7
Total Northern California	**2,604,591**	**100.0**

TABLE 3-B

Substation Delivery by Counties Grouped Geographically
(District Served by Southern Group of Companies)

County	*Substation delivery Thousands of kilowatt hours*	*Per cent of total southern group*
DISTRICT 1.		
Fresno	171,885	
Inyo	8,188	
Kern	256,869	
Kings	43,863	
Madera	33,457	
Mariposa	3,000	
Merced	69,341	
Mono	-----	
San Luis Obispo	16,423	
Santa Barbara	57,766	
Tulare	157,694	
Total, District 1	818,486	24.0
DISTRICT 2.		
Los Angeles	1,859,426	
Orange	138,361	
Ventura	56,814	
Total, District 2	2,054,601	60.2
DISTRICT 3.		
Imperial	40,257	
Riverside	132,809	
San Bernardino	239,016	
San Diego	126,801	
Total, District 3	538,883	15.8
Total South San Joaquin Valley and southern California	3,411,970	100.0

PLATE III.



DISTRIBUTION OF ELECTRIC POWER LOAD BY COUNTIES IN CALIFORNIA 1927

PLATE IV.

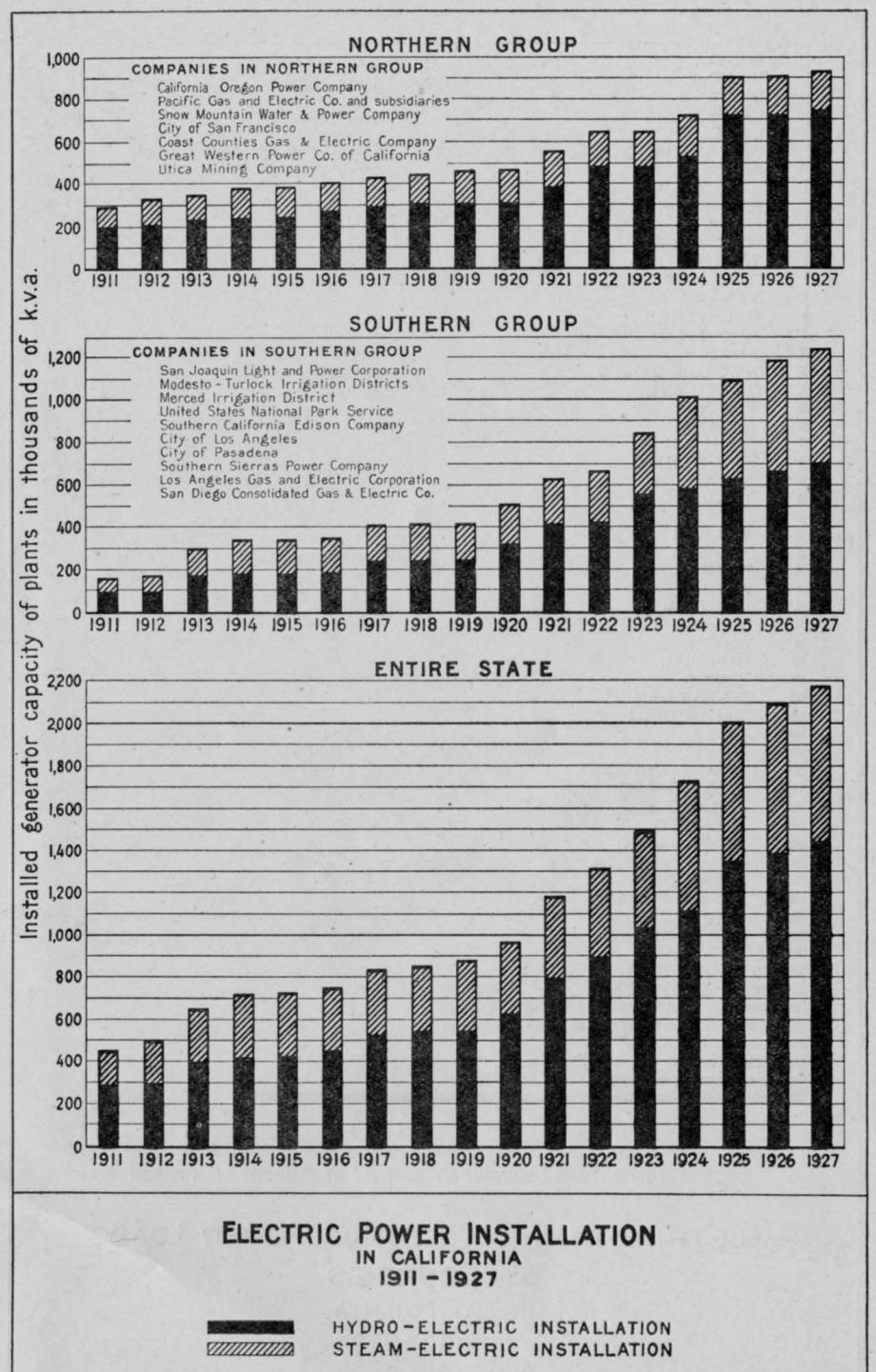

NORTHERN GROUP
COMPANIES IN NORTHERN GROUP
California Oregon Power Company
Pacific Gas and Electric Co. and subsidiaries
Snow Mountain Water & Power Company
City of San Francisco
Coast Counties Gas & Electric Company
Great Western Power Co. of California
Utica Mining Company
SOUTHERN GROUP
COMPANIES IN SOUTHERN GROUP
San Joaquin Light and Power Corporation
Modesto - Turlock Irrigation Districts
Merced Irrigation District
United States National Park Service
Southern California Edison Company
City of Los Angeles
City of Pasadena
Southern Sierras Power Company
Los Angeles Gas and Electric Corporation
San Diego Consolidated Gas & Electric Co.
ENTIRE STATE
Installed generator capacity of plants in thousands of k.v.a.
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
2,200
1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927
ELECTRIC POWER INSTALLATION
IN CALIFORNIA
1911 - 1927
HYDRO-ELECTRIC INSTALLATION
STEAM-ELECTRIC INSTALLATION

PLATE V.

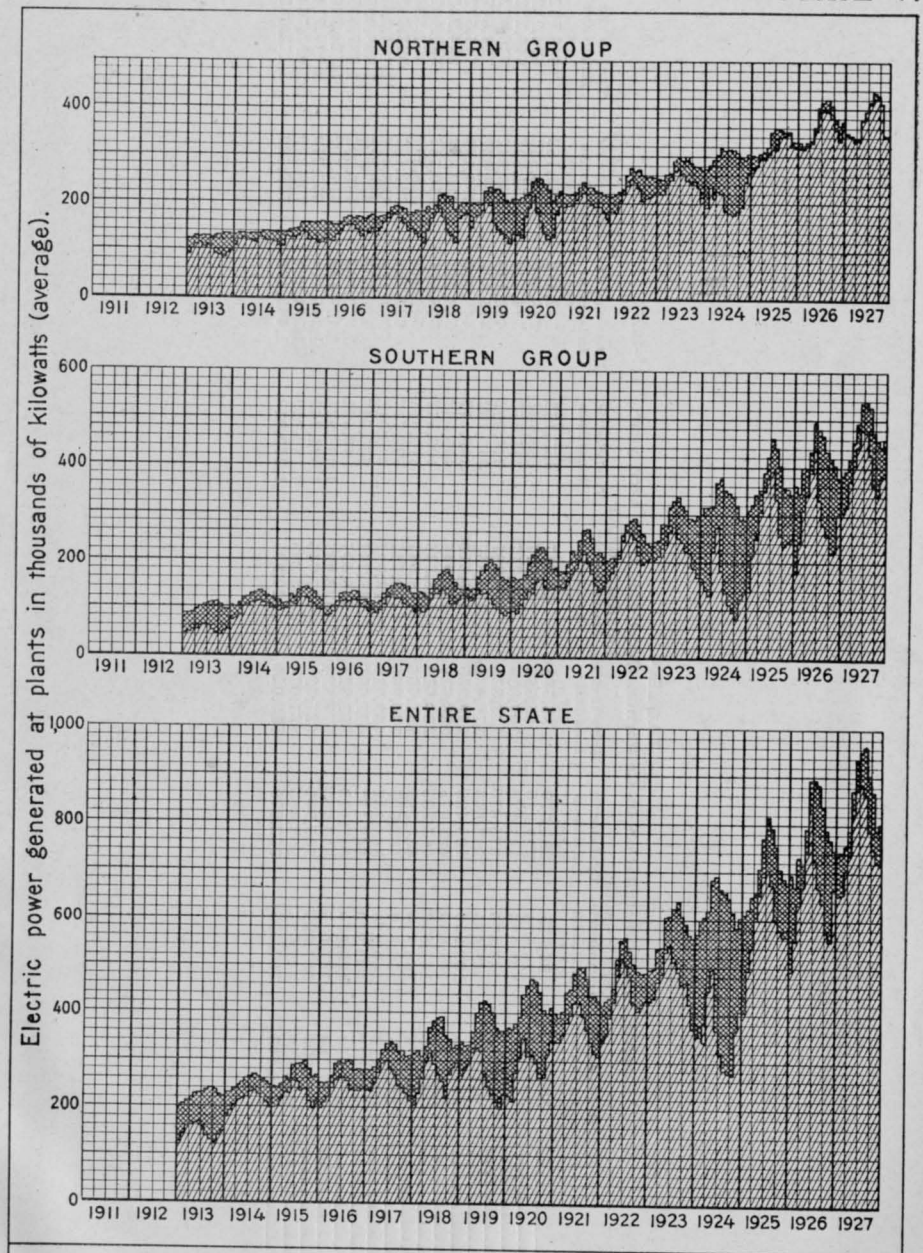

NORTHERN GROUP
SOUTHERN GROUP
ENTIRE STATE
Electric power generated at plants in thousands of Kilowatts (average).
0
200
400
600
800
1,000
1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927
ELECTRIC POWER PRODUCTION
IN CALIFORNIA
1913 - 1927
POWER PRODUCED BY HYDRO-ELECTRIC PLANTS
POWER PRODUCED BY STEAM-ELECTRIC PLANTS

TABLE 4

Electric Power Installation in California, December 31 of each year, 1911–1927

Year	NORTHERN GROUP			SOUTHERN GROUP			ENTIRE STATE		
	Hydro-electric installation k.v.a	Steam-electric installation k.v.a	Total electric installation k.v.a.	Hydro-electric installation k.v.a.	Steam-electric installation k.v.a.	Total electric installation k.v.a.	Hydro-electric installation k.v.a.	Steam-electric installation k.v.a.	Total electric installation k.v.a.
1911	196,795	94,575	291,370	85,585	69,577	155,162	282,380	164,152	446,532
1912	202,795	126,575	329,370	85,585	79,977	165,562	288,380	206,552	494,932
1913	226,795	121,375	348,170	167,835	130,217	298,052	394,630	251,592	646,222
1914	239,295	136,375	375,670	173,835	166,967	340,802	413,130	303,342	716,472
1915	241,170	141,675	382,845	174,435	166,367	340,802	415,605	308,042	723,647
1916	268,475	132,950	401,425	179,935	166,212	346,147	448,410	299,162	747,572
1917	286,725	141,950	428,675	236,616	168,946	405,562	523,341	310,896	834,237
1918	302,075	141,810	443,885	236,616	168,946	403,562	538,691	310,756	849,447
1919	300,575	156,810	457,385	241,466	168,547	410,013	542,041	325,357	867,398
1920	301,725	156,810	458,535	320,066	183,647	503,713	621,791	340,457	962,248
1921	378,822	169,310	548,132	409,916	216,097	626,013	788,738	385,407	1,174,145
1922	472,872	169,310	642,182	417,666	248,247	665,913	890,538	417,557	1,308,095
1923	471,972	175,200	647,172	551,824	288,697	840,521	1,023,796	463,897	1,487,693
1924	527,320	187,625	714,945	577,824	432,097	1,009,921	1,105,144	619,722	1,724,866
1925	718,320	187,625	905,945	627,324	467,645	1,094,969	1,345,644	655,270	2,000,914
1926	720,820	187,625	908,445	661,074	522,245	1,183,319	1,381,894	709,870	2,091,764
1927	744,445	187,625	932,070	699,024	540,995	1,240,019	1,443,469	728,620	2,172,089

Table 5 sets forth by years the production of power, both hydro-electric and steam-electric in millions of kilowatt hours for the years 1913 to 1927. The figures include a relatively small production of power by plants of the California-Oregon Power Company and the Truckee River Power Company outside the State.

TABLE 5

Electric Power Production in California, 1913–1927

Year	Annual power plant output in millions of kilowatt hours: Hydro-electric	Steam-electric	Total	Steam-electric in per cent of total
*Northern group**				
1913	852	266	1118	23.8
1914	1028	146	1174	12.4
1915	1072	220	1292	17.0
1916	1219	208	1427	14.6
1917	1332	242	1574	15.4
1918	1350	386	1736	22.2
1919	1343	473	1816	26.0
1920	1409	576	1985	29.0
1921	1719	253	1972	12.8
1922	1905	268	2173	12.3
1923	2118	302	2420	12.5
1924	1833	812	2645	30.7
1925	2721	162	2883	5.6
1926	3102	130	3232	5.0
1927	3266	32	3298	1.0
Southern group				
1913	439	414	853	48.5
1914	858	173	1031	16.8
1915	911	170	1081	15.7
1916	894	137	1031	13.3
1917	930	242	1172	20.6
1918	1014	319	1333	23.9
1919	994	491	1485	33.1
1920	1163	543	1706	21.8
1921	1485	449	1934	13.2
1922	1886	287	2173	13.2
1923	1995	627	2622	13.9
1924	1335	1561	2896	53.5
1925	2462	836	3298	25.3
1926	2577	1091	3668	29.7
1927	3443	644	4087	15.8
*Entire State**				
1913	1291	680	1971	34.5
1914	1886	319	2205	14.5
1915	1983	390	2373	16.4
1916	2113	345	2458	14.0
1917	2262	484	2746	17.6
1918	2364	705	3069	23.0
1919	2337	964	3301	29.2
1920	2572	1119	3691	30.3
1921	3204	702	3906	18.0
1922	3791	555	4346	12.8
1923	4113	929	5042	18.4
1924	3168	2373	5541	42.8
1925	5183	998	6181	16.1
1926	5679	1221	6900	17.7
1927	6709	676	7385	9.2

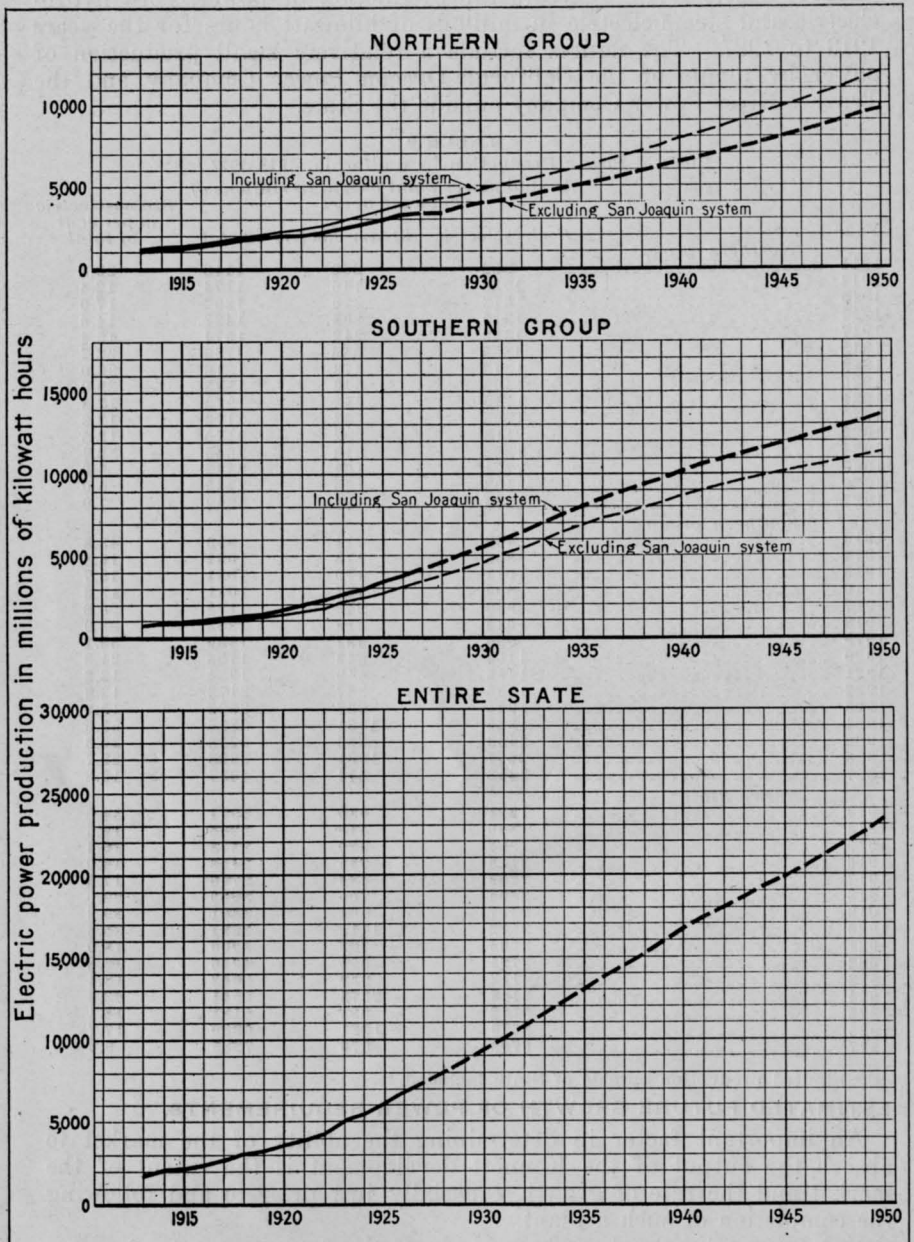
* Limited production outside of State included.

ESTIMATED FUTURE GROWTH OF POWER REQUIREMENTS.

An important factor in determining the ability of the market to absorb the output of the Kennett development is the extent of the market and the rate of growth, especially just prior to and following the completion of such a plant.

Numerous estimates have been made of the future growth of power in the State of California. The past growth in northern California has been steady, though not as rapid as in southern California. There has been apparently some slowing up of the growth in southern California during the past few years. Studies of estimates of growth of power requirements prepared by Mr. F. E. Bonner of the Federal Power Commission, together with other analyses of past and estimated future growth, have been made in connection with this report. The resultant conclusions are set forth in Plate VI, "Past and Estimated

PLATE VI.



PAST AND ESTIMATED FUTURE GROWTH OF ELECTRIC POWER PRODUCTION IN CALIFORNIA 1913 – 1950

ELECTRIC POWER PRODUCTION FOR PAST YEARS

ESTIMATED ELECTRIC POWER PRODUCTION FOR FUTURE YEARS

Future Growth of Electric Power Production in California, 1913–1950," and in Table 6 for the two sections of the State. The past growth of power in northern California has been at a compound rate approximating 8 per cent. The estimates herein, however, contemplate the future growth at a reducing percentage, ranging from approximately 7 per cent in 1928, to as low as 4 per cent about 1950.

DATE OF BRINGING IN KENNETT.

The date of completion of Kennett development will have an important bearing on the ability of the market to absorb its potential power output. The construction program contemplates a period of four and one-half years for completion. Allowing for preliminaries and financing, it may be concluded that the earliest time for bringing in this development would be 1935. For the purposes of this discussion, however, completion by 1936 has been assumed. Should the completion occur at a later date, the market could more readily absorb the power output.

POWER OUTPUT OF KENNETT.

The power output of Kennett, when operated for flood and salinity control, and limited irrigation, is estimated at an average of 1,217,600,000 kilowatt hours annually. This output is based on a 275,000 kilovolt-ampere plant operating at 80 per cent power factor and with an output equivalent to approximately 70 per cent plant load factor.

TABLE 6

Estimated Future Power Requirement, 1927–1950

(Power Plant Output)

Year	*Northern Group, millions of kilowatt hours*	*Southern Group, millions of kilowatt hours*	*Entire State, millions of kilowatt hours*
1927	3,219	4,090	7,309
1928	3,433	4,572	8,005
1929	3,668	5,054	8,722
1930	3,919	5,492	9,411
1931	4,125	6,017	10,142
1932	4,343	6,499	10,842
1933	4,570	6,981	11,551
1934	4,811	7,507	12,318
1935	5,063	8,032	13,095
1936	5,328	8,470	13,798
1937	5,606	8,908	14,514
1938	5,897	9,346	15,243
1939	6,205	9,740	15,945
1940	6,539	10,178	16,717
1941	6,806	10,573	17,379
1942	7,083	10,923	18,006
1943	7,372	11,273	18,645
1944	7,673	11,624	19,297
1945	7,984	11,930	19,914
1946	8,310	12,237	20,547
1947	8,647	12,587	21,234
1948	8,997	12,938	21,935
1949	9,362	13,201	22,563
1950	9,728	13,551	23,279

These bases of estimates are somewhat conservative. The output under the conditions as set forth will vary from a minimum of 990,400,000 kilowatt hours to a maximum of 1,314,000,000 kilowatt hours annually. Table 7 sets forth the estimated output which could have been developed under the water supply conditions of 1896–1927 had Kennett been installed. The relative variation of output both annually and monthly, compared with other typical plants, is presented graphically on Plate VII, "Variation of Annual and Monthly Power Output of Kennett Reservoir Compared with Typical Hydro-electric Plants."

The Kennett output for the minimum year has been estimated to meet the normal variation of power demand on the main power systems and is under these conditions more valuable than that from the other plants. Although shown as uniform throughout the maximum year, the output could be varied to follow more closely the power demand.

The output characteristics under condition of practically complete control for irrigation, which will ultimately occur, are very different and will materially reduce the value of the power available. An estimate of the conditions under such control based on a use of water to the level of two hundred feet above the stream bed indicates an average annual output of 767,000,000 kilowatt hours with a variation in output from 46 per cent to 138 per cent of the average. Unless such a limit on the minimum head is provided much less power could be produced in the dry years and the value of the output would be materially reduced.

TABLE 7

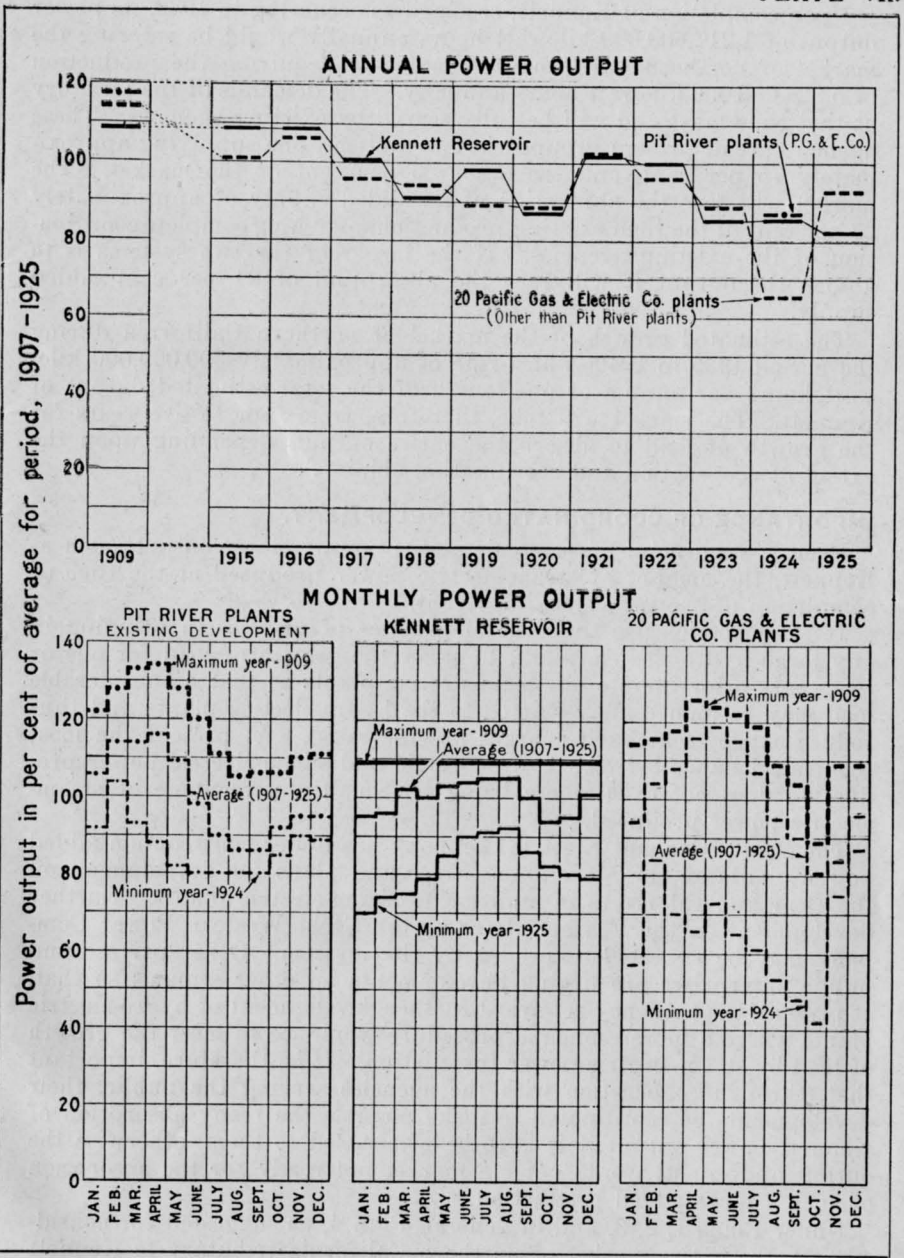
Estimated Power Output, Kennett Reservoir—420 foot dam

Operated for Flood Control, Saline Control and an Irrigation Supply to San Joaquin Valley.

Installed Capacity of Plant, 275,000 k.v.a. Power Factor = 0.80. Load Factor = 0.75

Year	*Power output in millions of kilowatt hours*
1896	1310.7
1897	1287.9
1898	1074.7
1899	1104.0
1900	1242.9
1901	1192.5
1902	1288.5
1903	1252.5
1904	1314.0
1905	1288.6
1906	1314.0
1907	1314.0
1908	1291.2
1909	1314.0
1910	1283.8
1911	1308.7
1912	1240.0
1913	1229.7
1914	1314.0
1915	1314.0
1916	1314.0
1917	1215.8
1918	1098.6
1919	1186.3
1920	1054.5
1921	1227.7
1922	1208.0
1923	1031.7
1924	1035.4
1925	990.4
1926	1049.6
1927	1271.5
Average: 1896-1927	1217.6

PLATE VII.



VARIATION OF ANNUAL AND MONTHLY POWER OUTPUT OF KENNETT RESERVOIR COMPARED WITH TYPICAL HYDRO-ELECTRIC PLANTS

MARKET AVAILABLE AT TIME OF COMPLETION.

Upon completion of Kennett, assumed as occurring in 1936, its power output of 1,217,600,000 kilowatt hours annually would be entering the market of northern California, estimated as requiring the production of 5,328,000,000 kilowatt hours annually. The demands of the territory at that time must and will be fully served by existing agencies. These agencies are at present grouped in two systems, one supplying approximately 75 per cent, and the other 25 per cent of the market. The market will face the absorption of an added supply of approximately 23 per cent of the then existing production, assuming complete coordination of the existing agencies. If the larger of the two systems is to absorb the output it will face the absorption of 31 per cent added supply.

The estimated growth of the market of northern California during the period 1935 to 1940 is at a rate of approximately 300,000,000 kilowatt hours per annum or one-fourth of the total estimated output of Kennett. The market will take, therefore, from four to five years for the growth of load to absorb the entire output, depending upon the extent of cooperation and coordination obtained.

IMPORTANCE OF COORDINATED DEVELOPMENT.

From a standpoint of economic absorption of power output, such as Kennett, the amount of steam-electric power produced at the time of completion of the project is important.

It is economic, also the general practice of utilities in bringing in any large hydro-electric plant, to carry the growth of load for one or two years prior thereto on steam-electric plants so that a considerable load may be immediately shifted to the hydro-electric plants and thus reduce expenses as fixed charges are increased. At present the most economic balance between hydro-electric and steam-electric power production does not exist, there being too small a percentage of steam-electric power produced.

The Pacific Gas and Electric Company has under construction added power plants on the Mokelumne River and plans for development on the Bear and Pit rivers in addition to steam-electric plants. Further development on the Feather River by the Great Western Power Company may be expected as needed by that system. Other private and public enterprises are urging developments on other streams so that, at present, the tendency is toward further development of hydro-electric plants where a more economic procedure would be to meet the growth of load by steam-electric power installation. It is, therefore, important that, through cooperation with the agencies serving the public, their developments be coordinated to make possible the ready absorption of Kennett power output if it is to be wholesaled to them, otherwise the output of Kennett would enter a market not ready for the absorption of such a large added production.

Under Plans 1, 2, 3, and in general, Plan 4, as suggested for consideration, the entire market of northern California tributary to Kennett power may be considered available for absorption of the output through the system of the existing utility agencies. These agencies, through the extent and diversity of their load, have developed a market fully interconnected through their systems with a load factor in excess of 60 per cent and a flexibility such that the power output could be readily

absorbed. If definite obligations for sale and purchase are entered into, under Plans 2, 3 and 4, other developments may be adjusted sufficiently in advance to make possible a minimum period of absorption. Much more extreme problems have been faced and overcome in the past than are presented by Kennett. In 1921, the Great Western Power Company brought in on its own system the first units of the Caribou development, the output of which represented in excess of 40 per cent of the then existing load on that system. In 1925, the Pacific Gas and Electric Company completed its Pit No. 3 plant, commenced the purchase of additional power from the California-Oregon Power Company and the City of San Francisco, the total amount exceeding 40 per cent of its then existing load. Kennett output will represent from 23 per cent to 31 per cent of the load at the time it is available.

With reasonable coordination and cooperation between this development and existing agencies no serious difficulty should arise in the absorption of power produced by Kennett development.

The problem of obtaining a market for the output of Kennett plant were the market to be developed through state-owned and operated distribution systems as suggested in Plan 5, is one to be considered separately.

COST OF KENNETT DEVELOPMENT

INVESTMENT COST.

The cost of the Kennett development (420 foot dam, 2,940,000 acre-foot reservoir) was estimated in Bulletin No. 13, "The Development of the Upper Sacramento River," at $80,000,000. That estimate was prepared on the basis of a power plant capacity of 400,000 kilovolt-amperes and with interest during construction at a rate of 6 per cent per annum. In this report the power plant capacity has been taken at 275,000 kilovolt-amperes as explained on page 15 of this report, and the interest rate reduced to a State financing basis of 4½ per cent. With these revisions the estimated cost is $70,000,000. This covers purchase of reservoir site and removal to new location of the Southern Pacific Company tracks and a part of the State highway that would be submerged, construction of the dam and a 275,000 kilovolt-ampere power plant. The total cost is divided as follows:

Lands and improvements flooded	$22,882,000
Dam and appurtenances	30,118,000
Total reservoir and dam	$53,000,000
Power plant	17,000,000
Total development	**$70,000,000**

ANNUAL COST OF KENNETT DEVELOPMENT.

The annual cost of Kennett development (reservoir, dam and power plant) will vary in the first three of the five plans of financing suggested, owing to differences in costs between private and state ownership and financing. The annual cost of this development will be the same under Plans 3, 4 and 5, as each contemplates complete State ownership of the reservoir, dam and power plant. The annual costs are fully set forth in Table 8 and are based on the following units:

Basis of Estimated Annual Cost Kennett Reservoir and Power Plant

	Private ownership	*State ownership*		
Bond amortization basis		*Straight line*	*Sinking fund*	*Excluded*
Return or interest per cent of capital	7.5	4.5	4.5	4.5
Amortization of state bonds—40 year basis, per cent of capital	--	2.5	1.05	--
Depreciation:				
Land and improvements, per cent of capital	--	--	--	--
Dam and appurtenances, per cent of capital	.3	.3	.3	.3
Power plant, 40 year basis, per cent of capital	.65	1.05	1.05	1.05
Taxes:				
State, per cent of capital	1.35			
Federal, per cent of capital	.40			
Operating expense and maintenance, both private and state ownership	$200,000 per annum for dam and reservoir. $300,000 per annum for power plant.			

Return on private investment is that at present generally estimated as fair for large electric projects such as Kennett. The interest rate of 4.5 per cent for State investment is slightly above the present cost. Amortization is assumed on a basis of a forty-year period commencing ten years after date of issue of bonds. This period is within the legal limit for State bonds (seventy-five years). Ten years for construction and loading of power plant prior to commencement of amortization are allowed for. Estimated costs under straight line amortization show the maximum annual charges with State development. A 4 per cent sinking fund amortization is included in the table in order to set forth the approximate average annual cost during the forty-year amortization period. The estimate, excluding amortization, sets forth the cost

TABLE 8

Estimated Annual Cost Kennett Reservoir and Power Plant

Division	Capital	Plan 1 Private development: Including state and federal taxes (based on average tax rate)	Plan 1 Private development: Excluding state tax	Plan 2 State development of reservoir and dam. Private development of power plant: *Straight line amortization of state bonds, state taxes included	Plan 2 State development of reservoir and dam. Private development of power plant: Sinking fund amortization of state bonds, state taxes excluded	Plan 3 State development of reservoir, dam and power plant: *Straight line amortization of bonds	Plan 3 State development of reservoir, dam and power plant: Sinking fund amortization of bonds	Plan 3 State development of reservoir, dam and power plant: Excluding amortization of bonds
Reservoir and dam	$53,000,000							
Interest or return		$3,975,000	$3,975,000	$2,385,000	$2,385,000	$2,385,000	$2,385,000	$2,385,000
Amortization				1,325,000	556,000	1,325,000	556,000	
Depreciation		90,000	90,000	90,000	90,000	90,000	90,000	90,000
State tax		407,000						
Federal tax		212,000	212,000					
Operation and maintenance		200,000	200,000	200,000	200,000	200,000	200,000	200,000
Totals, reservoir and dam		$4,884,000	$4,477,000	$4,000,000	$3,231,000	$4,000,000	$3,231,000	$2,675,000
Power plant	17,000,000							
Interest or return		$1,275,000	$1,275,000	$1,275,000	$1,275,000	$765,000	$765,000	$765,000
Amortization						425,000	178,000	
Depreciation		111,000	111,000	111,000	111,000	178,000	178,000	178,000
State tax		229,000		229,000				
Federal tax		68,000	68,000	68,000	68,000			
Operation and maintenance		300,000	300,000	300,000	300,000	300,000	300,000	300,000
Totals, power plant		$1,983,000	$1,754,000	$1,983,000	$1,754,000	$1,668,000	$1,421,000	$1,243,000
Reservoir, dam and power plant:								
Interest or return		$5,250,000	$5,250,000	$3,660,000	$3,660,000	$3,150,000	$3,150,000	$3,150,000
Amortization				1,325,000	556,000	1,750,000	734,000	
Depreciation		201,000	201,000	201,000	201,000	268,000	268,000	268,000
State tax		636,000		229,000				
Federal tax		280,000	280,000	68,000	68,000			
Operation and maintenance		500,000	500,000	500,000	500,000	500,000	500,000	500,000
Totals, reservoir, dam and power plant	$70,000,000	$6,867,000	$6,231,000	$5,983,000	$4,985,000	$5,668,000	$4,652,000	$3,918,000
Total cost in per cent of capital		9.81	8.90	8.55	7.12	8.10	6.65	5.60
Total cost per kilowatt hour produced	1,217,600,000 kwh.	$0.00564	$0.00512	$0.00491	$0.00409	$0.00466	$0.00382	$0.00322

* Estimated costs under straight line amortization represent maximum money requirements which occur in first year of amortization period.

during the first years; also the estimated carrying cost of the development, excluding retirement of capital.

The length of bond amortization might be increased to a sixty or sixty-five year period under the legal limitation and thus reduce the annual outlay. The table, however, indicates the limits between which the results, based on other assumptions, will fall. No depreciation has been assumed on lands or improvements removed. A minimum of 0.3 per cent has been included on the dam and appurtenances to cover contingencies and minor replacements. Depreciation on the power plant is estimated on forty years' life on a 6 per cent sinking fund for private and 4 per cent sinking fund for State ownership.

Operating and maintenance expenses are estimated to cover not only local but also general expenses and are somewhat higher than a study of expenses of the larger developments of the State would indicate in order to cover possible contingencies.

The table sets forth the estimated cost under private ownership of capital with and without State taxes. Under the present method of taxing electric utilities a private utility would pay the same State tax were it to purchase the power wholesale from the State as it would if the plant were constructed and owned by it, the tax being determined as a per cent of the total gross revenue of the utility. For comparison with costs of other power, therefore, the cost has been estimated excluding State taxes. The present State tax rate is 7.5 per cent of the gross revenue. Assuming revenue would equal total cost the resultant tax rate would be seventy-two hundredths of 1 per cent of the capital under Plan 1. This basis can hardly be expected to continue indefinitely. The rate of 1.35 per cent of capital is based on the average tax rate on general property now existing over the State equated to a per cent of capital cost. No State tax is estimated on the capital representing lands and improvements as the greater part of this cost represents cost of relocation of the railroad and highway and would not represent power company property.

COST OF TRANSMISSION.

Plan 4 contemplates construction and operation of trunk transmission lines to the important load centers of northern California, power to be wholesaled to political subdivisions and private utilities.

As indicated in Plate II and Tables 2, 3-A and 3-B, over 65 per cent of the market is located within a radius of 50 miles of San Francisco. From Table 1, it is to be noted that at present 94 per cent of the power is served directly by two companies. Further data show that within the Sacramento Valley and the San Francisco Bay region less than 2 per cent of the power is distributed by municipal systems, only one individual system distributing over 0.5 of 1 per cent of the existing load. These systems are scattered from Redding on the north to Santa Clara on the south. This does not include the Modesto and Turlock districts which produce their own power and would require only standby service.

Transmission of such a large amount of power as Kennett output will require as a minimum, a double circuit 220,000 volt transmission line to the main load center in the Bay district.

It is apparent from an engineering consideration of the data that outside of the two main companies there are at present no municipal

or private resale systems of sufficient size or advantageous location to take power economically from the main trunk transmission line. Should another system develop which could avail itself of the purchase of power wholesale it must be assumed that the revenue to be received would justify the added capital expenditure. At present only two agencies of sufficient size to utilize the output of Kennett exist: one, the Pacific Gas and Electric Company; the other, the Great Western Power Company of California. If transmission of power by the State is contemplated the logical terminal of the transmission line would be in the general vicinity of Antioch, Contra Costa County, practically two hundred miles' transmission distance from Kennett. Both companies have important substations and transmission lines in this location which is near the center of load.

The cost of transmission per kilowatt hour will vary materially, depending on the plan of operation and whether adequate standby service against interruption is contemplated. By wholesaling the output to these two agencies the cost to the State will be reduced to a minimum. Under such delivery the transmission line can be limited to two circuits and one substation as the purchasing systems with their steam-electric and hydro-electric plants and extensive transmission networks will be adequate in size to take care of interruptions without detriment to the public service.

If the State contemplates delivery of power comparable in continuity to that now delivered by existing utilities an additional transmission line and steam-electric standby plant would be required in excess of that herein estimated.

Table 9 sets forth the estimated investment and annual cost to the State and to a private utility to transmit Kennett power to the load center wholesaling it to the existing agencies. This represents the minimum capital and annual cost requirements for transmission.

TABLE 9

Cost of Transmission of Kennett Power, Kennett to Antioch

Investment Cost

Transmission line—200 miles double circuit tower line	$6,000,000
Receiving substation, 200,000 kilowatt capacity	3,600,000
Total	$9,600,000

Power delivered 88% of 1,217,600,000 kilowatt hours = 1,070,000,000 kilowatt hours.

Basis of Annual Cost

Per cent of Capital

	State development		
	Straight line amortization	*Sinking fund amortization*	*Private development*
Interest or return	4.5	4.5	7.50
Amortization—40 years	2.5	1.05	-----
Depreciation	1.35	1.35	1.00
Maintenance and operating expense, including general expense:			
Transmission line	.75	.75	.75
Terminal substation	2.50	2.50	2.50
Taxes, state and federal	---	---	1.75

Annual Cost

1. Transmission line:			
Interest on $6,000,000	$270,000	$270,000	$450,000
Amortization	150,000	63,000	-----
Depreciation	81,000	81,000	60,000
Maintenance and operating expense	45,000	45,000	45,000
Taxes	-------	-------	105,000
Total cost of transmission to substations	$546,000	$459,000	$660,000

2. Receiving substation:			
Interest on $3,600,000	$162,000	$162,000	$270,000
Amortization	90,000	37,800	-----
Depreciation	48,500	48,500	36,000
Operating expense	90,000	90,000	90,000
Taxes	-------	-------	63,000
Total cost of receiving substation	$390,500	$338,300	$459,000
3. (a) Total cost of transmission	$936,500	$784,300	$1,119,000
(b) Total cost of transmission, excluding state taxes	-------	-------	989,600
4. Cost per kilowatt hour delivered, a	$0.000875	$0.000733	$0.001044
b	-----	-------	0.000924

From Tables 8 and 9, the total cost to the State under Plan 4, assuming the wholesaling of power to the existing agencies, may be summarized as follows:

		Annual cost	
	Capital cost	*Straight line amortization of bonds—40 years*	*Sinking fund amortization of bonds—40 years*
1. Dam, reservoir and power plant	$70,000,000	$5,668,000	$4,652,000
2. Cost per kilowatt hour produced—(1,217,600,000 kilowatt hours)	----------	($0.00466)	($0.00382)
3. Transmission line and substation	9,600,000	936,500	784,300
4. Totals	$79,600,000	$6,604,500	$5,436,300
5. Total cost per kilowatt hour delivered from terminal substation—(1,070,000,000 kilowatt hours)	----------	($0.00617)	($0.00508)

In the above table and in Table 9, preceding, the figures under straight line amortization represent the maximum costs which occur during the first year of the amortization period.

VALUE OF POWER OUTPUT

The value of the power output of Kennett and the revenue from the power under Plans 1, 2, 3 and 4 will depend upon the characteristics of the output and upon the cost of power from other and competitive sources. Power that is available mainly in spring months or in wet years is less valuable, requiring more auxiliary steam-electric power installation than power which can be depended upon under adverse conditions of drought. Plate VII, heretofore referred to, sets forth graphically the estimated annual and monthly variation of power from Kennett compared with other hydro-electric plants of northern California. This comparison shows that Kennett power under the conditions of operation specified has better characteristics than the power from other plants.

There are three measures of the value of power, based upon cost of power from other sources:

1. Cost of power from other hydro-electric plants.
2. Cost of power from steam-electric plants.
3. Wholesale price for power as indicated by existing contracts.

Throughout this analysis comparison will be made on a unit basis of mills per kilowatt hour. Such a basis is only correct where power characteristics and point of delivery are equivalent. These units are better understood, however, and will be used with qualifying statements.

COST OF POWER FROM OTHER HYDRO-ELECTRIC PLANTS

The potential water power resources of California have been inventoried and summarized by Mr. F. E. Bonner of the Federal Power Commission, in a report just issued by that commission. Table 10, compiled from Table 9 of the Bonner Report, shows the present and principal ultimate development of the water power resources of the State. This shows by main streams the present and estimated ultimate installed capacity and output in average kilowatts, and ultimate output in millions of kilowatt hours. Although these figures are not directly comparable with estimates of kilowatt hours and plant capacities shown in other portions of this report, they are indicative of the extent of the present development, the potential development and the main source of future production of power in California from hydro-electric sources. It is to be noted from the table that 70 per cent of the potential hydro-electric power of California exists on streams north of Merced and tributary to northern California, and only 30 per cent in the territory tributary to southern California. Present development in the north is only 14 per cent of the total potential and indicates that for a long period undeveloped resources will exist.

The important streams of northern California are the Klamath; the Pit, McCloud and Sacramento group; the Feather and the American rivers. The important streams tributary to southern California are the San Joaquin and Kings. In view of the relative proximity of the Pit and Feather rivers to the Kennett development, the cost of power

TABLE 10. Summary of Water-power Resources of California

From Table 9, "Report to Federal Power Commission on the Water Powers of California," by Frank E. Bonner

Drainage basin	Existing development: No. plants	Existing development: Installed capacity, kw.	Existing development: Output average, kw.	Ultimate development [a]: No. plants	Ultimate development [a]: Installed capacity, kw.	Ultimate development [a]: Output average, kw.	Ultimate development [a]: Output, millions of kwh.	Per cent of group	Per cent of state
Northern group:									
1. Smith River	4	56,200	27,170	17	808,200	508,881	4,457.8	15.9	
2. Klamath River [b]	3	2,775	800	12	303,000	180,925	1,584.9	5.7	
3. Trinity River	1	6,800	5,700	2	11,000	8,800	77.1	.3	
4. Eel River	4	120,500	89,964	11	480,500	316,346	2,771.2	9.9	
				4	221,500	133,705	1,171.3	4.2	
5. Pit River									
6. McCloud River				9	469,000	257,647	2,257.0	8.1	
7. Sacramento River	6	37,000	19,097						
Totals (5–7, inclusive)	10	157,500	109,061	24	1,171,000	707,698	6,199.5	22.2	
8. Deer and Mill creeks				2	60,000	45,000	394.2	1.4	
9. West Fork Feather and Butte Creek	4	22,400	13,863	4	22,400	13,863	121.4	.4	
10. Feather River	4	175,800	105,023	24	1,065,800	698,251	6,116.7	21.8	
11. Yuba River (including Bear River)	9	114,375	74,200	18	389,675	251,707	2,205.0	7.9	
12. American River	3	29,000	14,270	22	546,000	317,408	2,780.5	9.9	
13. Mokelumne River	1	19,400	7,954	6	138,000	94,405	827.0	3.0	
14. Stanislaus River	7	73,200	31,393	16	293,700	207,680	1,819.3	6.5	
15. Tuolumne River	4	117,600	73,400	8	241,300	160,743	1,408.1	5.0	
Totals (1–15, inclusive)	50	775,050	462,834	155	5,050,075	3,195,361	27,991.5	100.0	70.5
Per cent of ultimate development			14			100			
Southern group:									
16. Merced River	6	34,150	15,810	12	93,650	47,541	416.4	3.5	
17. San Joaquin River	11	404,300	251,142	24	960,100	524,667	4,596.1	39.0	
18. Kings River	4	31,500	13,700	15	609,000	407,750	3,571.9	30.3	
19. Kaweah River	3	6,700	4,727	3	6,700	4,727	41.4	.3	
20. Tule River	2	7,500	4,205	2	7,500	5,791	50.7	.4	
21. Kern River	4	76,500	52,209	9	198,500	119,952	1,050.8	8.9	
22. Truckee River [c]	1	1,650	596	3	7,500	5,000	43.8	.4	
23. Carson River				1	6,000	4,000	35.0	.3	
24. Walker River	1	500	300	2	15,500	9,400	82.3	.7	
25. Mono Lake	4	25,000	8,380	3	24,100	7,582	66.4	.5	
26. Bishop Creek	5	24,475	13,927	6	27,575	17,124	150.0	1.3	
27. Owens River	12	103,320	34,246	20	244,860	162,564	1,424.1	12.1	
28. Santa Clara River				3	23,000	8,000	70.1	.6	
29. San Gabriel River	1	2,000	1,152	1	2,000	1,152	10.1	.1	
30. Santa Ana River	11	15,475	10,062	15	29,675	18,462	161.7	1.4	
31. Salton Sea	3	3,030	1,255	5	5,830	2,295	20.1	.2	
32. San Diego County	2	800	400	2	800	400	3.5	.0	
33. Miscellaneous	1 [d]	950	350	1	950	350	3.1	.0	
Totals (16–33, inclusive)	68	737,850	412,461	127	2,263,240	1,346,757	11,797.5	100.0	29.5
Per cent of ultimate development			31			100			
Total State (1–33, inclusive)	118	1,512,900	875,295	282	7,313,315	4,542,118	39,789.0	.....	100.0

[a] Including existing developments.
[b] Excluding part in Oregon.
[c] Excluding part in Nevada.
[d] Swanton Plant, Santa Cruz County.

TABLE 11

Estimated Cost of Hydro-Electric Power from Present and Future Pit and Feather River Developments

	Pit River developments *Pacific Gas and Electric Company*		*Feather River developments* *Great Western Power Company*	
	Present	*Future*	*Present*	*Future*
1. Plants included	Pit 1 and 3 Hat Creek 1 and 2	Pit 2, 4, 5 and 6	Caribou and Las Plumas	Plants 1–8b
2. Plant capacity	176,000 kva.	306,000 kva.	133,000 kw.	593,750 kw.
3. Average annual output	828 million kwh.	1,583 million kwh.	870 million kwh.	3,430 million kwh.
4. Investment cost	$23,233,000	$40,100,000	$29,300,000	$105,704,000
5. Basis of computing annual cost:				*Per cent of capital*
Return				7.5
Depreciation				0.65
Operating, maintenance and general expense				0.75
Taxes:				
Federal				.40
State				1.35
Total				10.65
6. Total annual cost:				
(a) Including state tax	$2,474,315	$4,270,650	$3,120,450	$11,257,476
(b) Excluding state tax	2,160,669	3,729,300	2,724,900	9,830,472
7. Cost per kwh. average output:				
(a) Including state tax	$0.00299	$0.00270	$0.00359	$0.00328
(b) Excluding state tax	$0.00261	$0.00236	$0.00314	$0.00287

from the present and future developments on these streams will indicate fairly closely the cost of power from other hydro-electric sources competitive with Kennett. These streams are being developed by the two major agencies serving northern California, namely the Pacific Gas and Electric Company and the Great Western Power Company, and are the probable sources of the main development during the next ten years or more.

Table 11 sets forth the estimated cost of power from the present developments and the estimated cost of power from future developments contemplated on the Pit and Feather rivers by the Pacific Gas and Electric Company and the Great Western Power Company, respectively. The cost of electric power from existing plants is based upon the actual costs or estimated costs of the projects under present price levels. The cost for future plants is based on tentative estimates heretofore prepared by these companies. The costs with and without State taxes are shown for the reasons heretofore set forth.

The characteristics of power from the present Pit River development compared with Kennett are shown in Plate VII. The locations of the present developments on Pit River are approximately forty miles further from the power market than Kennett. This results in a differential in favor of Kennett of approximately two-tenths mills per kilowatt hour.

The characteristics of the power now being produced by the existing plants on the Feather River and that which may be produced by future plants are in general closely comparable with the primary or dry year output of Kennett development; that is, the minimum output of 990,400,000 kilowatt hours, per year. This greater dependability has been made possible by the large cyclic storage of water in Lake Almanor at the upper end of the series of plants.

It is to be noted from the table that the estimated cost including taxes for the present Pit development is approximately three mills per kilowatt hour and for the future development, two and seven-tenths mills, while the cost of power from the Feather River approximates three and six-tenths mills for present plants and three and three-tenths mills per kilowatt hour for future plants. These plants are 100 miles nearer the main power market than the Pit plants and the characteristics of power are better. If weight be given to these factors and the value of power measured at the load center near San Francisco Bay, the two sources of power are practically of equal value per kilowatt hour.

There are other potential developments of power, as indicated in Table 10 on the Klamath and south of the Feather River. Klamath, being approximately 90 miles further from the market, is subject to a differential in favor of Kennett of from four-tenths to five-tenths mills per kilowatt hour. The developments south of Feather River are in general at least 100 miles nearer the center of the power market than Kennett and therefore have a differential in their favor of from five-tenths to seventy-five hundredths mills per kilowatt hour, this differential including cost of transmission and shrinkage of kilowatt hours due to transmission losses.

The San Joaquin Valley power market depends upon the San Joaquin and Kings rivers mainly for hydro-electric power. The cost of

power from these streams is estimated at three to five mills per kilowatt hour of average annual output. The distance from Kennett to the market in the San Joaquin Valley is from 300 to 450 miles. Generally transmission of power in excess of 300 miles has not been justified. The differential for transmission from Kennett would be at least two mills per kilowatt hour which, deducted from an average cost of four mills would leave two mills or less per kilowatt hour for power at Kennett.

The potential power available from the main streams of northern California which may be economically developed would indicate that until this is utilized the value of Kennett power measured by competition with other hydro-electric sources would be between two and seven-tenths and three and three-tenths mills per kilowatt hour. As the more economical sources are used the value compared with other hydro-electric sources may tend to increase.

VALUE OF KENNETT POWER DETERMINED FROM COST OF POWER FROM STEAM-ELECTRIC PLANTS

COST OF STEAM-ELECTRIC POWER.

There has been during the last several years a marked increase in efficiency of steam-electric production. A still further improvement in efficiency may be expected. On the basis of 60 per cent plant load factor with present efficiencies the fuel requirements are 15,000 British thermal units or less per kilowatt hour produced. It appears from study of literature on the subject and from present trend of efficiency that reduction of the requirement to below 14,000 British thermal units may be expected in the near future and later as low as 12,000 British thermal units per kilowatt hour.

The question of price of oil is impossible of determination for any period of time. The present price is $1 per barrel. The price has fluctuated widely in the past. When the present condition of overproduction of oil is past, increase in price may be expected. Coal supply would indicate a limitation in fuel cost, however, to approximately the equivalent of $1.50 per barrel of oil.

Table 12 sets forth the estimated cost of power from a steam-electric plant operating at 60 per cent load factor to supply a load necessary to absorb fully the potential output of Kennett. The conditions of efficiency are those that should be obtained by new plants in the next few years. Oil has been estimated at $1 per barrel. The cost of power from recently constructed plants would, on a basis of $1 per barrel for oil, be two-tenths mills per kilowatt higher. Table 13 sets forth the estimated cost based on probable further efficiency development and price of oil of $1.25 per barrel.

It is to be noted that the cost of steam-electric power is divisible into two parts; one fixed and amounting to approximately $17 or $15.50 per kilowatt of capacity, depending upon treatment of taxes, and on output cost varying with the power produced from two to two and twenty-three hundredths mills per kilowatt hour.

EQUIVALENT VALUE OF HYDRO-ELECTRIC POWER.

A determination of the relative value of hydro-electric power by comparison with the cost of steam-electric power requires special care to insure equivalent bases, owing to market difference in fundamental characteristics of output and variation in costs between the two sources. The output of hydro-electric plants such as Kennett varies from year to year, depending upon conditions of precipitation. Costs are practically fixed and do not vary with output or with price of fuel. Steam-electric power output can be readily adjusted to demands, a considerable part of the cost varying directly with the output and the price of fuel. The determination of relative value has been made by load characteristics similar to those of northern California and sufficient to absorb the output of Kennett without wastage. This cost has then been compared with cost of power from Kennett with necessary auxiliary steam-electric power.

TABLE 12

Estimated Cost of Steam-Electric Power Basis of Probable Efficiency of Immediate Future

	Basis	
1. Steam-electric power installation to supply load equivalent to Kennett plus steam-electric auxiliary:		
(a) Annual production	1,275,000,000	kilowatt hours
(b) Capacity for 60% load factor, 243,000 kilowatts, use	250,000	kilowatt capacity
(c) Cost of power plant and connecting transmission line at $110 per kilowatt	$27,500,000	
2. Estimated efficiency: 1 bbl. of oil per kilowatt per year plus 1/500 bbl. of oil per kilowatt hour net output.		
3. Annual cost:		
(a) Return on investment	7.5%	
(b) Depreciation	2.25%	
(c) Operating expenses other than oil	$3.00 per kilowatt year	
(d) General expense	3% of cost other than oil and taxes	
(e) Oil	$1.00 per bbl.	
(f) Tax: State 1.35% Federal .40	1.75%	

4. Annual cost:	
(a) Fixed costs:	
Return at 7.5%	$2,062,500
Depreciation at 2.25%	618,750
Operating expense at $3	750,000
General expenses	102,940
Standby oil at $1	250,000
Taxes at 1.75%	481,250
Total fixed costs	$4,265,440
(b) Output costs:	
Oil at $.002 per kilowatt hour	2,550,000
(c) Total costs	$6,815,440

5. Unit costs:	(a) *Including state tax*	(b) *Excluding state tax*
Demand or fixed cost per kilowatt of capacity	$17.06	$15.57
Energy cost per kilowatt hour of output	.002	.002
6. Average cost per kilowatt hour	.00535	.00527

The steam-electric plant would be located on San Francisco Bay and as to relative distance to the market, would be equivalent to the terminal substation of Kennett transmission.

The cost of steam-electric power based on the estimates in Table 12 have been set up in Table 14 (Item "C"). From this has been deducted the annual cost of the auxiliary steam-electric plant required to supply the load without wastage of power from Kennett in years of maximum output. The balance (Item E-10) represents the relative value of Kennett Power delivered at Antioch. Deducting the cost of transmission the relative value of Kennett power at the plant is determined.

TABLE 13

Estimated Cost of Steam-Electric Power Basis of Probable Efficiency Future

Basis

1. Steam-electric power installation to supply load equivalent to Kennett plus steam-electric auxiliary:			
(a) Annual production		1,275,000,000	kilowatt hours
(b) Capacity for 60% load factor, 243,000 kilowatts, use		250,000	kilowatt capacity
(c) Cost of power plant and connecting transmission line at $110 per kilowatt		$27,500,000	
2. Estimated efficiency: 75 bbl. of oil per kilowatt per year plus 1/560 bbl. of oil per kilowatt hour net output.			
3. Annual cost:			
(a) Return on investment		7.5%	
(b) Depreciation		2.25%	
(c) Operating expenses other than oil		$3.00	per kilowatt year
(d) General expense		3%	of cost other than oil and taxes
(e) Oil		$1.25	per bbl.
(f) Tax: State	1.35%		
Federal	.40		
		1.75%	
4. Annual cost:			
(a) Fixed costs:			
Return at 7.5%		$2,062,500	
Depreciation at 2.25%		618,750	
Operating expense at $3		750,000	
General expenses		102,940	
Standby oil at $1.25		234,000	
Taxes at 1.75%		481,250	
Total fixed costs		$4,249,440	
(b) Output costs: Oil at $.00223 per kilowatt hour		2,843,325	
(c) Total costs		$7,092,765	

5. Unit costs:	(a) *Including state tax*	(b) *Excluding state tax*
Demand or fixed cost per kilowatt of capacity	$17.00	$15.58
Energy cost per kilowatt hour of output	.00223	.00223
6. Average cost per kilowatt hour	.00556	.00527

TABLE 14

Comparison of Value of Kennett Power With Steam-Electric Produced Power

A. Kennett development 220,000 kilowatts—275,000 kilovolt-amperes.			
1. Output of Kennett plant annual average		1,217,600,000	kwh.
2. Delivery from terminal substation		1,070,000,000	kwh.
3. Steam-electric auxiliary plant output required to supply load that will absorb Kennett output without wastage		205,000,000	kwh.
4. Total output basis of terminal delivery		1,275,000,000	kwh.
5. Steam-electric auxiliary capacity required based on maximum monthly requirement 80% load factor		62,500	kw.
B. Steam-electric power equivalent.			
6. Steam-electric plant capacity to supply load on 60% load factor basis 243,000 kw., use		250,000	kw.
C. Steam-electric plant costs.		*Including tax*	*Excluding tax*
7. Demand charge unit cost		$17.00	$15.50
8. Demand cost	250,000 kw.	$4,250,000	$3,875,000
Energy cost	1,275,000,000 kwh.	2,550,000	2,550,000
Totals		$6,800,000	$6,425,000
Per kilowatt hour delivered		.00538	.00504
D. Auxiliary steam-electric cost.			
9. Demand cost	62,500 kw.	$1,062,000	$968,750
Energy cost	205,000,000 kwh.	410,000	410,000
Totals		$1,472,000	$1,378,750
E. Value of hydro-electric power at substation terminals.			
10. Available for hydro-electric power from transmission (8)–(9)		$5,328,000	$5,046,250
Per kilowatt hour delivered	(1,070,000,000 kwh.)	.00498	.00471
11. Transmission cost		$1,119,000	$989,600
F. Value of hydro-electric power at Kennett		$4,209,000	$4,056,650
12. Value per kilowatt hour	(1,217,600,000 kwh.)	.00347	.00334
13. Value per kilowatt hour based on future steam plant efficiency and oil at $1.25 per bbl.		.00868	.00355

Similar comparison has been made of the relative value of Pit power now developed. This computation is shown in Table 15. The difference of two-tenths mill per kilowatt hour in the unit values between Kennett and Pit is accounted for mainly by the greater transmission distance to Pit plants.

TABLE 15

Comparative Value of Pit Power With Steam-Electric Produced Power

A. Pit development 141,600 kilowatts.			
1. Output of Pit developments, annual average		828,000,000 kwh.	
2. Delivery from terminal substation, 14% transmission loss		713,000,000 kwh.	
3. Steam-electric auxiliary plant output required to supply load that will absorb Pit output without wastage		387,000,000 kwh.	
4. Total output based on terminal delivery		1,100,000,000 kwh.	
5. Steam auxiliary capacity required based on maximum monthly requirements 80% load factor		92,500 kw.	
B. Steam-electric power equivalent.			
6. Steam plant capacity to supply load on 60% load factor basis 209,000 kilowatts use		215,000 kw.	
C. Steam-electric plant costs.		*Including tax*	*Excluding tax*
7. Unit demand cost		$17.00	$15.50
8. Demand cost	215,000 kw.	$3,655,000	$3,332,500
Energy cost	1,100,000,000 kwh.	2,200,000	2,200,000
Totals		$5,855,000	$5,532,500
Per kilowatt hour delivered		.00533	.00505
D. Auxiliary steam-electric cost.			
9. Demand	92,500 kw.	$1,572,500	$1,433,400
Energy	387,000,000 kwh.	774,000	774,000
Totals		$2,346,500	$2,207,400
E. Value of hydro-electric power at substation terminals.			
10. Available for hydro-electric power from transmission (8)–(9)		$3,508,500	$3,325,100
Per kilowatt hour delivered	(713,000,000 kwh.)	.00493	.00467
11. Transmission cost		$845,000	$733,000
F. Value of hydro-electric power at Pit plants		$2,663,500	$2,592,100
12. Value per kilowatt hour	(828,000,000 kwh.)	.00322	.00313
13. Value based on future steam-electric plant efficiency and oil at $1.25 per bbl.		.00342	.00333

The value of Kennett power measured at the power plant, determined from comparison with steam-electric power, is between three and thirty-four hundredths and three and sixty-eight hundredths mills per kilowatt hour based on the prices of oil considered.

MARKET PRICE OF POWER AS DETERMINED FROM EXISTING CONTRACTS

There exists at the present time in the northern and central parts of the State, six main contracts covering the purchase by utilities of the output of hydro-electric plants constructed by irrigation districts, municipalities or other public utilities. These contracts and purchases involve the following:

1. Merced Irrigation District and San Joaquin Light and Power Corporation.
2. Turlock Irrigation District and San Joaquin Light and Power Corporation.
3. South San Joaquin and Oakdale Irrigation Districts and Pacific Gas and Electric Company.
4. City of San Francisco and Pacific Gas and Electric Company.
5. Feather River Power Company and Great Western Power Company of California.
6. California Oregon Power Company and Pacific Gas and Electric Company.

These contracts, in total, involve the delivery of approximately the amount of power to be produced at the Kennett development.

There are two other contracts not readily comparable which have not been included but, in so far as can be ascertained, indicate somewhat lower prices than the six contracts considered.

1. Merced Irrigation District and San Joaquin Light and Power Corporation.

This contract involves delivery of power at the high tension terminal of the power plant on the Merced River. The power is seasonal in character and the output fluctuates between wide limits from wet to dry years. The contract was entered into when costs of construction and competitive costs of power were higher than at the present time. The price is four and five-tenths mills per kilowatt hour and delivery is approximately fifty miles from a point which may be considered equivalent to Bay district delivery of Kennett power.

2. Turlock Irrigation District and San Joaquin Light and Power Corporation.

This contract provides for delivery at Livingston or Merced Falls of the surplus power of the Turlock Irrigation District. Obligation to purchase is maximum from June to December and reduced during the months of January to May. The price is four and five-tenths mills per kilowatt hour. Delivery is practically equivalent in location to Merced District delivery.

3. South San Joaquin and Oakdale Irrigation Districts and Pacific Gas and Electric Company.

In this case the dam and reservoir were constructed by the Districts, the power company constructed the power plant and in addition to its own costs pays to the Districts for a period of forty years an amount equal to interest and amortization on the Districts' capital. The cost, including estimated State tax based upon power plant output, is approximately four and two-tenths mills per kilowatt hour. The contract provides, however, that after the forty-year period the power company

is obligated to pay to the districts only half of the operation and maintenance of the dam and reservoir and nothing in the way of return. The power is seasonal in character and involves fairly wide fluctuations between wet and dry years. Equivalent transmission distance is approximately 50 miles.

4. City of San Francisco and Pacific Gas and Electric Company.

This contract provides for delivery at Newark substation, which is comparable with delivery at Antioch, of the output of the Moccasin Creek plant at 75 per cent daily load factor. The power supply is dependable from the standpoint of variation from wet to dry years, but the contract provides for cancellation. This contract represents the largest power delivery and the nearest comparable with the delivery of power from Kennett reservoir to a point such as Antioch. The price is four and eight hundred seventy-eight thousandths plus mills per kilowatt hour.

5. Feather River Power Company and Great Western Power Company of California.

This contract provides for a delivery of 40,000 kilowatts at approximately 60 per cent annual load factor at the high tension terminals of the power plant transformers, a distance of 150 miles from the Bay area. The price is four mills per kilowatt hour, but the contract provides that at the end of thirty-five years the total power development of the Feather River Power Company will become the property of the Great Western Power Company. The purchase of property feature in the contract represents about twenty-five hundredths mills per kilowatt hour.

6. The California Oregon Power Company and Pacific Gas and Electric Company.

The agreements between these companies call for 30,000 kilowatts delivery at 70 per cent load factor, measurement at Cottonwood substation of the Pacific Gas and Electric Company, but provide that the purchasing company will construct a part of the transmission line between the California Oregon Power Company plants and Cottonwood substation. The price for power at 70 per cent load factor or less is four and five-tenths mills per kilowatt hour. The point of delivery is comparable generally with delivery at Kennett power plant.

Table 16 sets forth certain statistics with reference to the six agreements, showing the approximate annual power delivery, the voltage and point of delivery, the relative characteristics of the power compared with Kennett power, the approximate distance to the general market comparable with the 200 miles transmission from Kennett to Antioch, the equivalent delivery, the price covered by the contract, this price equated to delivery equivalent to Antioch for Kennett power, and to delivery at Kennett. In the determination of the differential between the various prices actually paid for power and the equivalent price at Antioch and Kennett, transmission costs and losses have been estimated as proportional to relative transmission distance from the power market.

TABLE 16

Comparison of Contract Prices for Power Purchased from Hydro-electric Power Plant Developments

Company	Approximate amount of power purchased: Kw. peak	Kwh. annually	Equivalent delivery from transmission at market kwh. annually	Delivery: Voltage (nominal)	Delivery: Point	Power Characteristics (a)	Approximate distance to general market, miles	Contract period—years	Price per kwh. mills (at delivery point)	Cost of equivalent delivery from transmission, mills per kwh. delivered	Resultant prices comparable to Kennett delivery at power plant, mills per kwh. delivered
1. Merced Irrigation District and San Joaquin Light and Power Corporation..	30,000	120,000,000	116,500,000	60,000	Power Plant	Seasonal 80% load factor 40%–130% annual variation (*)	50	20	4.5	4.9	3.39
2. Turlock Irrigation District and San Joaquin Light and Power Corporation..	2,500 to 6,500†	40,000,000	38,500,000	60,000	Merced Falls and Livingston	Annual (‡)	50	15	4.5	4.9	3.39
3. South San Joaquin and Oakdale Irrigation districts and Pacific Gas and Electric Company (b)	25,000	100,000,000	97,000,000	60,000	Power Plant	Seasonal load factor not determined 62%–130% annual variation (*)	50	40	4.2	4.6	3.13
4. City of San Francisco and Pacific Gas and Electric Company	75,000	475,000,000	475,000,000	110,000	Newark Sub.	75% load factor practically no annual variation (†)	0	Subject to cancellation	4.878	4.878	3.37
5. Feather River Power Company and Great Western Power Company of California (c)	40,000	208,000,000	187,500,000	220,000	Power Plant	Annual 63% load factor (‡)	150	35	4.00	5.19	3.64
6. California-Oregon Power Company and Pacific Gas and Electric Company (d)	30,000	180,000,000	158,500,000	110,000	Near Delta measured at Cottonwood	Annual 70% load factor (‡)	200	25	4.5	6.17	4.50
Totals	204,500	1,123,000,000	1,073,000,000							4.96 (e)	3.45
7. Kennett Development	220,000	1,217,600,000	1,070,000,000	220,000	Power Plant	Annual 70% load factor 81.5%–108.2% annual variation	200				

(a) Seasonal indicates mainly spring and summer power.
"40%–130% annual variation" indicates variation in annual output wet and dry years.
(†) Indicates better than Kennett.
(‡) Indicates equal to Kennett.
(*) Less valuable than Kennett.

(b) Pacific Gas and Electric Company constructed and owns power plant. 4.2 mills = estimated cost, including taxes — amortization of district investment. Cost of amortization approximately 0.2 mills per kwh.

(c) Price covers amortization of investment in plant in 35 years. This equals approximately 0.24 mills per kwh.

(d) Major part of transmission capital already invested so that cost delivered not as great as 6.17 mills.

(e) Computed on basis of eliminating amortization referred to in (b) and (c) and ½ transmission cost of (d).

The purchase price for power from the California-Oregon Power Company is high, considered both from a standpoint of cost of hydroelectric power and in comparison with other contracts. At the time the contract was entered into, the Pacific Gas and Electric Company had excess transmission capacity from Cottonwood substation to Vaca-Dixon substation. It would still have this excess in lines from Vaca-Dixon to Antioch when completed for delivery of power to Antioch. For a part of the period of the contract, therefore, the added transmission cost of this power would be relatively small. This condition could not be applied to Kennett power, which in itself would require two transmission circuits. The Pacific Gas and Electric Company, however, could, by coordinating its transmission lines with those from Kennett, obtain some advantage over conditions under separate operation.

The purchases from the City of San Francisco, Feather River Power Company, the California-Oregon Power Company and the Turlock Irrigation District are equal to or slightly better than Kennett in quality of power. The total purchases under the contracts are practically equivalent in amount and in quality of power to Kennett power. With the adjustments for plant purchase in rates under certain contracts and for transmission capacity available in the case of the California-Oregon Power Company, the resultant value at Kennett is three and forty-five hundredths mills per kilowatt hour, and at Antioch four and ninety-six hundredths mills per kilowatt hour.

The above analysis indicates that from the standpoint of comparison with existing contracts for power, the value of electric power from Kennett under conditions of limited flood, salinity and irrigation operation would be three and forty-five hundredths mills per kilowatt hour at the power plant.

CONCLUSIONS RELATIVE TO VALUE OF KENNETT POWER OUTPUT

The value of Kennett electric power based upon the operation of the reservoir for limited flood and salinity control and irrigation, would appear from the foregoing to be approximately as follows:

Kennett delivery:	Mills per kilowatt hour
1. Based on other hydro-electric developments	2.7 to 3.3
2. Based on steam-electric costs as estimated	3.34 to 3.68
3. Based on existing contracts	3.45

From the present indications as to future economic conditions, the revenue that may be obtained from the sale of the electric power output of Kennett at the plant may not be expected to exceed $4,250,000 and at the terminal transmission near the Bay district not to exceed $5,300,000 per annum. Changes in economic conditions in the future may tend to increase or reduce these values.

RELATION OF REVENUE FROM POWER TO ANNUAL COST OF KENNETT DEVELOPMENT

Comparison of annual costs, as set forth in Table 8, with the estimated maximum revenue from power $4,250,000 per annum, indicates that this power revenue can be expected to meet State costs, excluding amortization, with a margin of safety of approximately 8.5 per cent, or $332,000. The annual cost under Plan 3, including 40-year sinking fund amortization, will exceed the power revenue, as estimated, by $402,000. Under Plan 2, with sinking fund amortization of State bonds and exclusion of State taxes, the annual cost will exceed the revenue, as estimated, by $735,000.

VALUE OF ELECTRIC POWER OUTPUT UNDER FULL CONTROL OF KENNETT RESERVOIR FOR IRRIGATION.

As heretofore referred to, analysis of the conditions under control for irrigation indicates that in the extreme the average annual output of the Kennett development will be reduced to about 770,000,000 kilowatt hours, varying from a minimum of 350,000,000 kilowatt hours, provided a minimum head on the power plant of 200 feet can be maintained, to somewhat over 1,000,000,000 kilowatt hours. The proportion of dependable power would be so reduced and the secondary power subjected to such wide fluctuation that the economic value of the composite output under present economic conditions would not exceed $2,000,000 per annum.

OTHER SOURCES OF REVENUE REQUIRED.

Power can not be expected, even under State financing, to carry much more than interest, depreciation and operating expenses of the Kennett development. Other sources of revenue such as State or Federal aid, sale of water for irrigation and payments by other beneficiaries will be required to cover amortization requirements under State financing. Greater aid would be required to carry the total cost in case of private development.

PLAN 3a

TRANSMISSION OF POWER BY PRIVATE COMPANIES AS COMMON CARRIERS

Plan 3a suggests that the State sell power at Kennett to individual municipalities or private resale companies and that the private companies purchasing the larger portion of the output be required under their contracts to transmit power as common carriers from Kennett for these municipalities and private companies.

The service to municipalities and private companies distributing electric energy requires extensive secondary transmission and substation systems in addition to the main trunk transmission lines considered herein; also steam-electric standby plants to insure against shortage of power in years of low precipitation and interruptions. The power requirements of such companies are at much lower load factors (between 30 and 45 per cent) than the estimated load factor of the Kennett output (70 per cent). If power were to be purchased for such service at Kennett the price per kilowatt hour, owing to the lower use per kilowatt of demand, would have to be materially higher than the average costs or values referred to under Plans 1, 2 and 3 herein. For the same reason transmission costs per kilowatt hour would be higher than the average. The costs or values per kilowatt hour heretofore referred to are not, therefore, indicative of what the charges would be for such deliveries at Kennett or of the total cost of the energy delivered to the individual municipalities. The rates now in effect for wholesale power on the systems of the existing agencies are low compared with the cost of power production and transmission on these systems. The cost of hydro-electric power from the present utilities is equal to or less than the price that could be paid wholesale for Kennett power. The State, therefore, would not receive any greater net return from such a plan than could be obtained under Plan 3.

PLAN 5

STATE DISTRIBUTION OF ELECTRIC POWER FROM KENNETT

Plan 5 contemplates State ownership of the power development, transmission lines, steam-electric standby plants and the necessary distribution system required to distribute the electric energy to the general public. This plan is a material departure from Plans 1 to 4, inclusive, and will require the investment of at least twice the capital.

It is important in considering Plan 5 that a clear perspective be had of the present and future conditions of service.

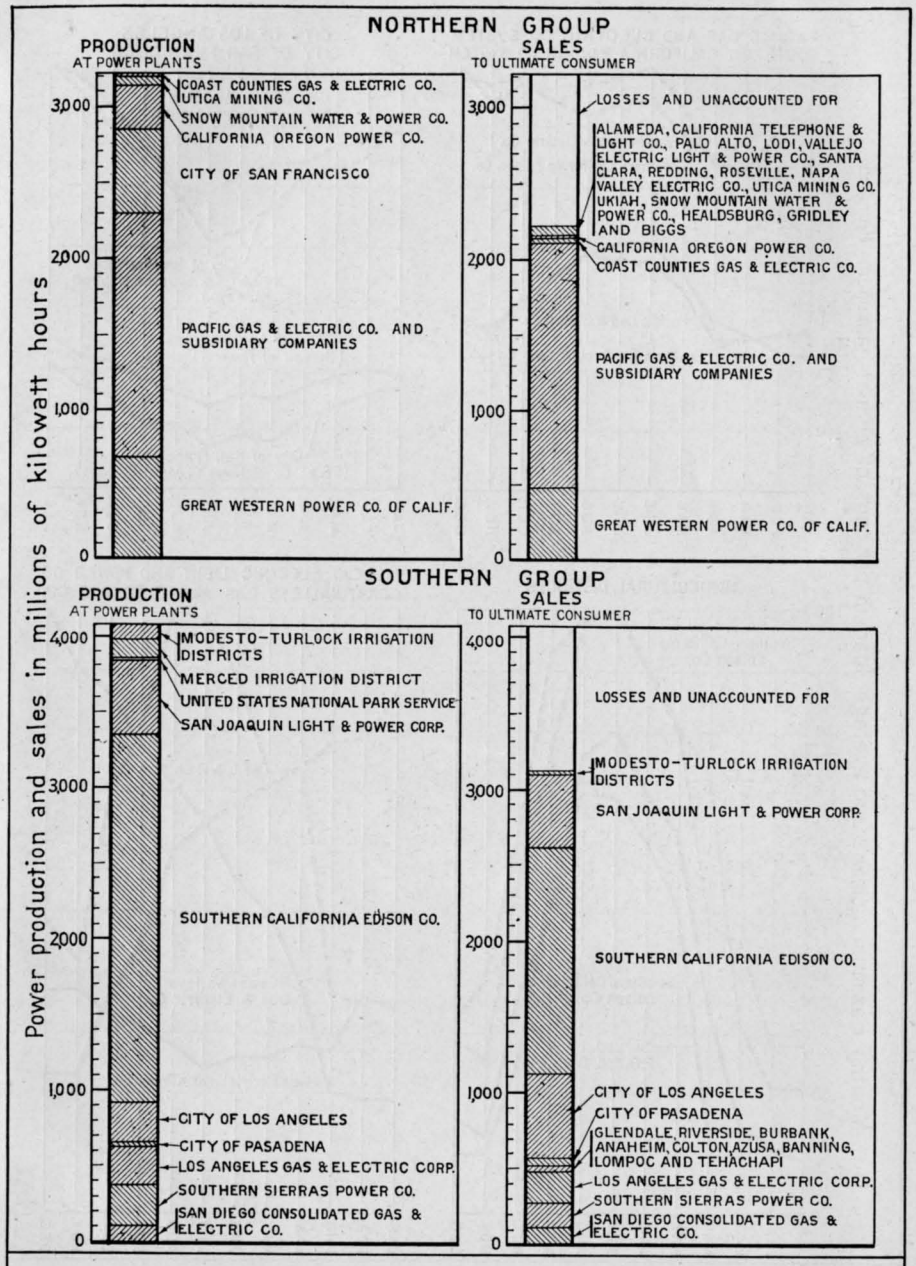
PRESENT DEVELOPMENT.

The past fifteen to twenty years of electric power development in the State have witnessed increasing consolidation of the electric utilities. Much of this has come about because of the possible economies from coordination and consolidation of the existing systems. This condition has developed to a greater extent in California than in many other states.

The market tributary to Kennett development is at present served by two main agencies supplying directly to the ultimate consumers 72 and 22 per cent, respectively, of the total load. At the time Kennett power would be available the entire market would be served by the existing agencies whose cost of power as far as production and transmission to the center of the market are concerned, is equal to or less than the cost that may be incurred by the State in the development of Kennett and no greater than the price the private utilities could pay for Kennett output in total. Plate VIII, "Electric Power Production and Sales by Companies in California, 1927," sets forth graphically the division of the market as indicated by production and sales by companies and political subdivisions for the northern and southern groups of the State for the year 1927. The relative extent of service by the various agencies in the northern part of the State is to be noted.

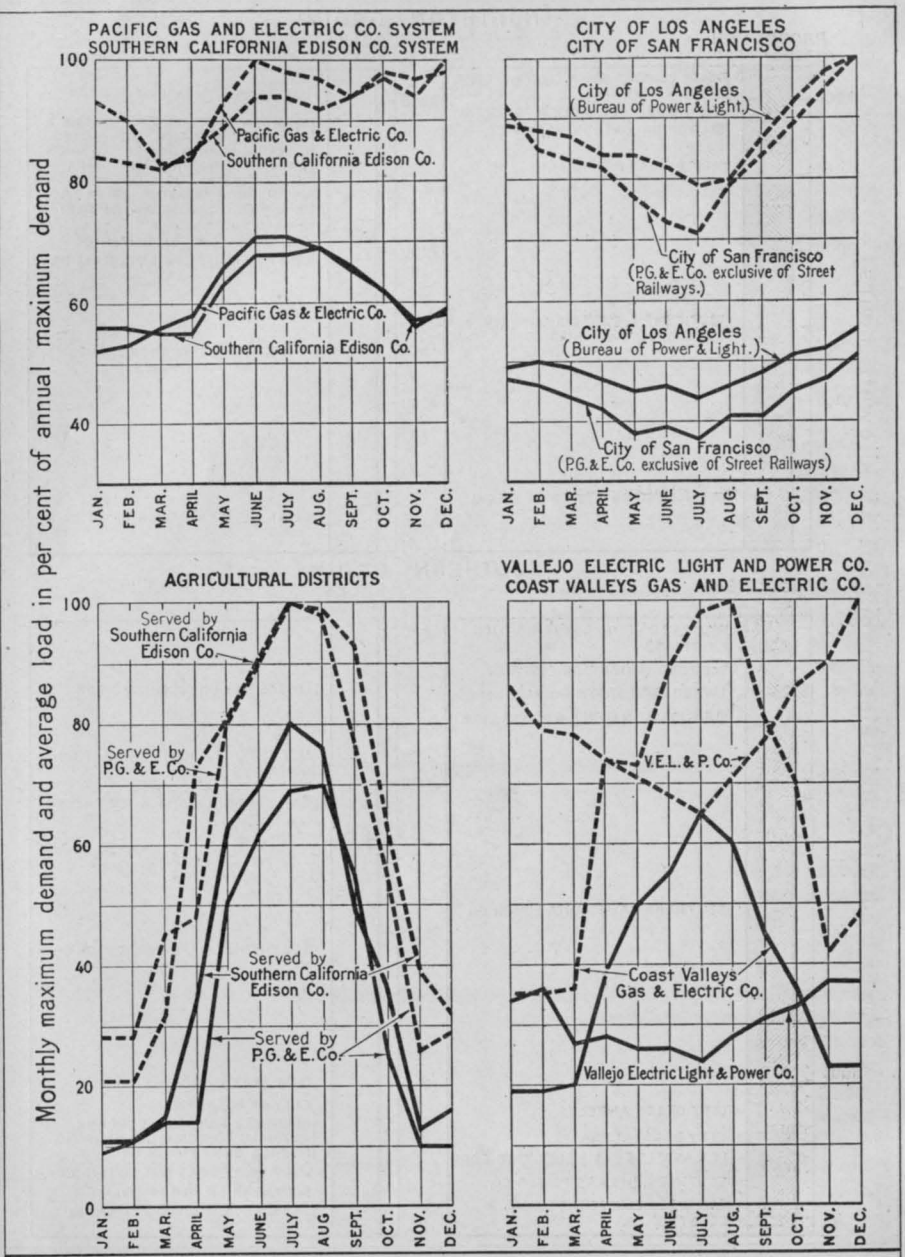
Plate IX, "Monthly Variation of Maximum Demand and Average Load for Typical Electric Power Systems in California, 1927," sets forth graphically some of the typical characteristics of the power demands of urban and rural territory. The upper right-hand chart indicates in percentage of the annual maximum requirement the variation in demand and energy requirements by months for two typical urban districts. The average use is approximately 45 to 50 per cent of the maximum demand and use is least in summer and greatest in winter. The lower left-hand chart gives characteristics of power for typical agricultural districts with their wide variation in demand and energy requirements, the maximum occurring generally in July, little requirement coming in winter. The lower right-hand chart indicates the wide variations between urban and rural power requirements. Compared with these characteristics for urban and rural power requirements is the upper left-hand chart giving similar characteristics of two of the most extensive electric systems of the State. This type of load is available to a development such as Kennett if its power were wholesaled to the existing agencies. Any one of the separate classes of service or districts could not supply a market which would readily

PLATE VIII.



ELECTRIC POWER PRODUCTION AND SALES
BY
COMPANIES AND POLITICAL SUBDIVISIONS
IN CALIFORNIA
1927

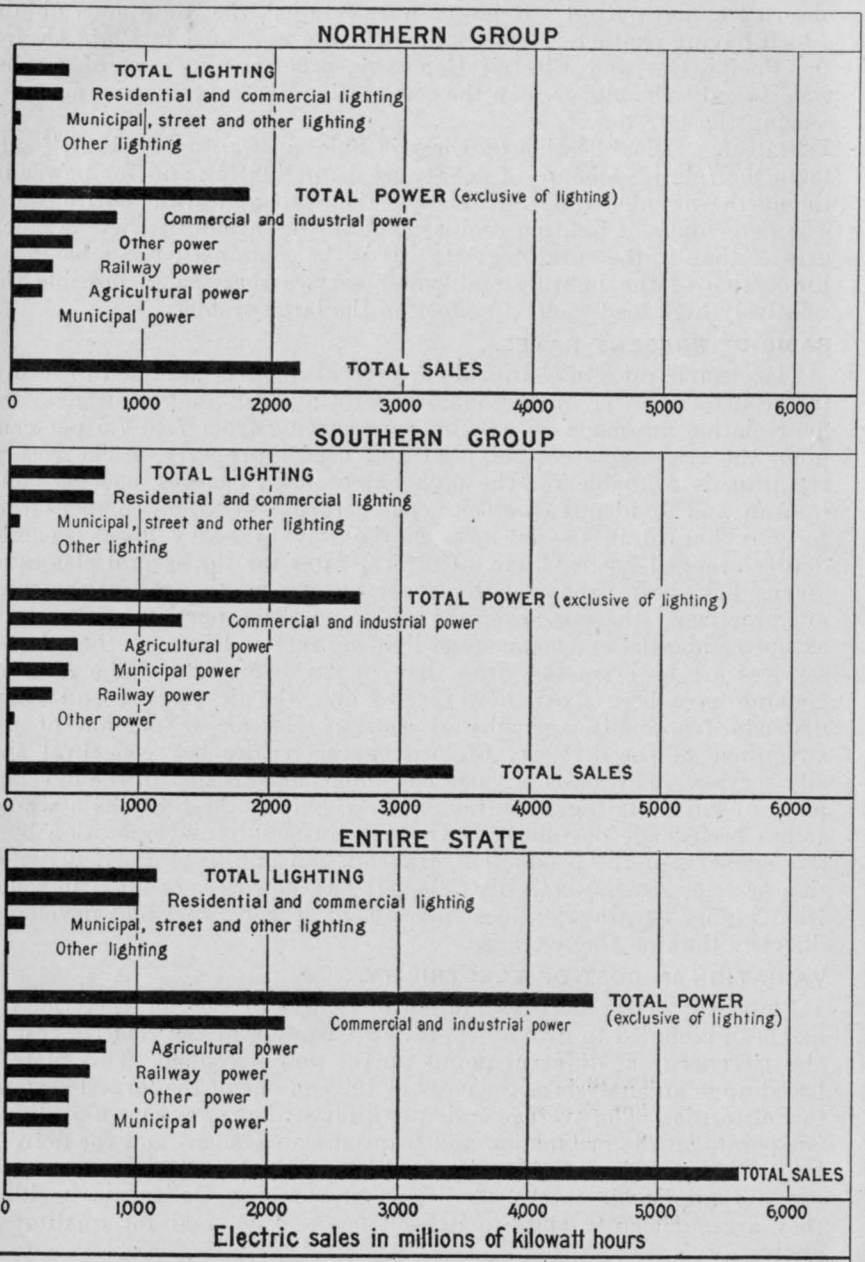
PLATE IX.



MONTHLY VARIATION OF MAXIMUM DEMAND AND AVERAGE LOAD FOR TYPICAL ELECTRIC POWER SYSTEMS IN CALIFORNIA 1927

---------- MAXIMUM DEMAND
———— AVERAGE LOAD

PLATE X.



CLASSIFICATION OF ELECTRIC SALES

IN CALIFORNIA

1927

absorb Kennett output. If power were retailed, the State must obtain a load having characteristics similar to those indicated in Plate IX for the Pacific Gas and Electric Company, otherwise its cost of service would tend to be higher than the cost on the existing two main agencies serving the territory.

Plate X, "Classification of Electric Sales in California, 1927," sets forth the relative amount of energy used for lighting and for power in the northern and southern districts of the State and in the entire State. The percentage of lighting requirements in the urban districts is much greater than in the rural districts. It is the combination of a balanced proportion of the lighting and power service that makes possible the relatively high load factor in effect on the large systems.

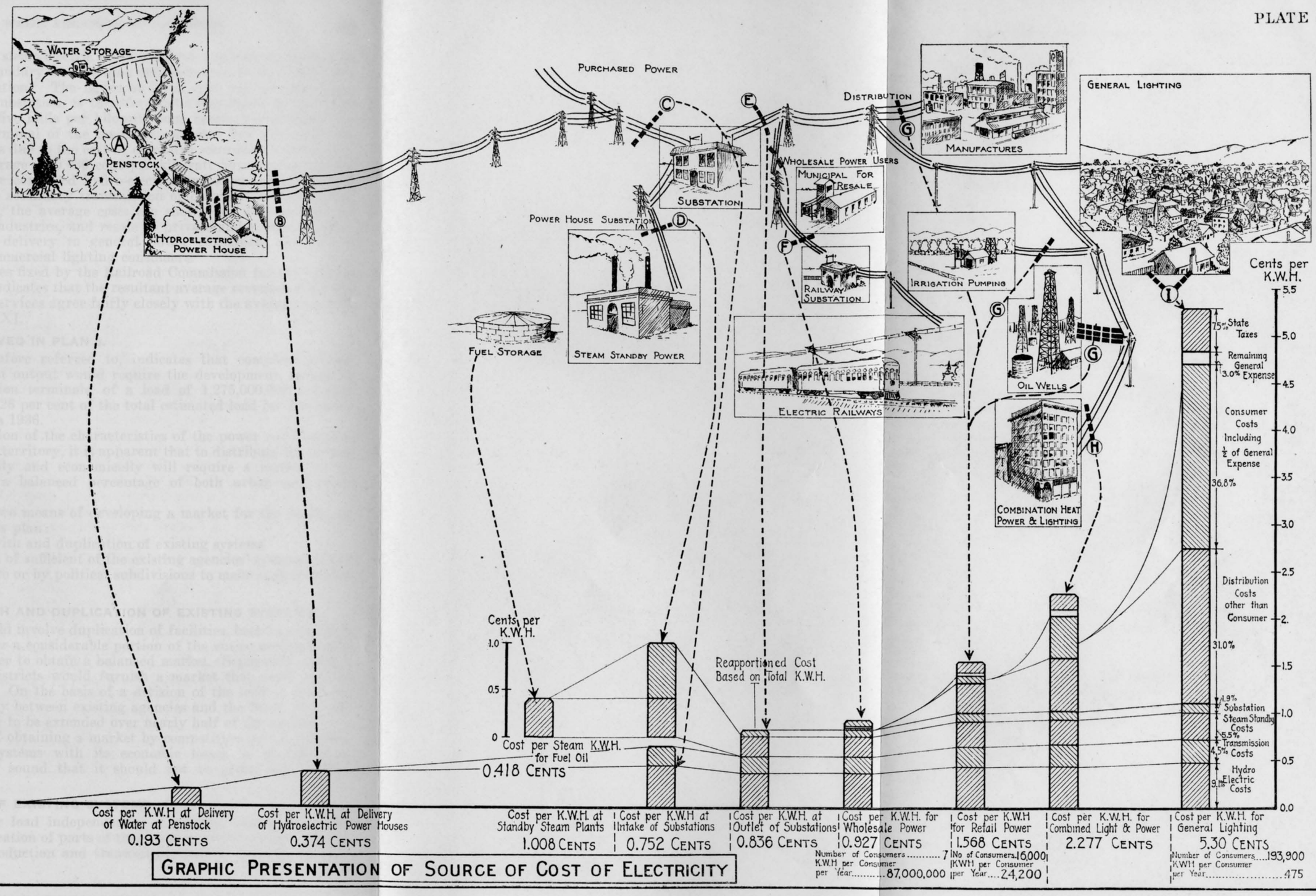
BASIS OF PRESENT RATES.

The electric rates in California at present in effect are fixed to return to the utilities after all reasonable operating costs and allowances for depreciation are made an amount representing from 7 to 7.5 per cent upon the reasonable cost of used and useful property. The return resulting is available for the payment of fixed charges such as bond interest and dividends on stock. The return also covers compensation for any hazard in the business in the way of heavy losses, general depreciation of business, etc. Uniform rates for the several classes of service have been fixed over the larger systems and at present the rates are practically the same over the entire northern portion of the state, except residential and commercial lighting rates. Rates for these latter services are lower in the cities than in rural districts. The rates in general have been fixed, however, to give the developing and rural districts (especially agricultural service) the major portion of the advantage of the diversity of load characteristics between rural and city service. This basis of rates has materially assisted in the development of rural and agricultural districts, and of the State as a whole. It has been made possible only through ownership and operation by a few agencies of the production, transmission and, especially, distribution systems serving both districts. It has, however, resulted in somewhat higher earnings on local investment in congested and developed districts than on the average.

VARIATION IN COST OF ELECTRICITY.

Plate XI, "Graphic Presentation of Source of Cost of Electricity," has been included to give a general visualization of the relative cost of electric energy at different points on the power system. This plate is based upon an analysis of the costs in 1923 on one of the largest systems in California. The average costs per kilowatt hour are shown at different points on the production and transmission systems and for deliveries to different classes of service. Although the costs indicated are not directly applicable to the conditions in northern California in 1928, they are sufficiently close to present costs to be used for qualitative analysis.

The average cost of 0.374 cent per kilowatt hour from hydro-electric plants is close to that existing on the main systems of northern California at the present time. Many of the hydro-electric plants are closer to the market than the Pit River or Kennett development, and this cost represents practically the equivalent value to Kennett power when weight is given to the difference in location relative to the market.



GRAPHIC PRESENTATION OF SOURCE OF COST OF ELECTRICITY

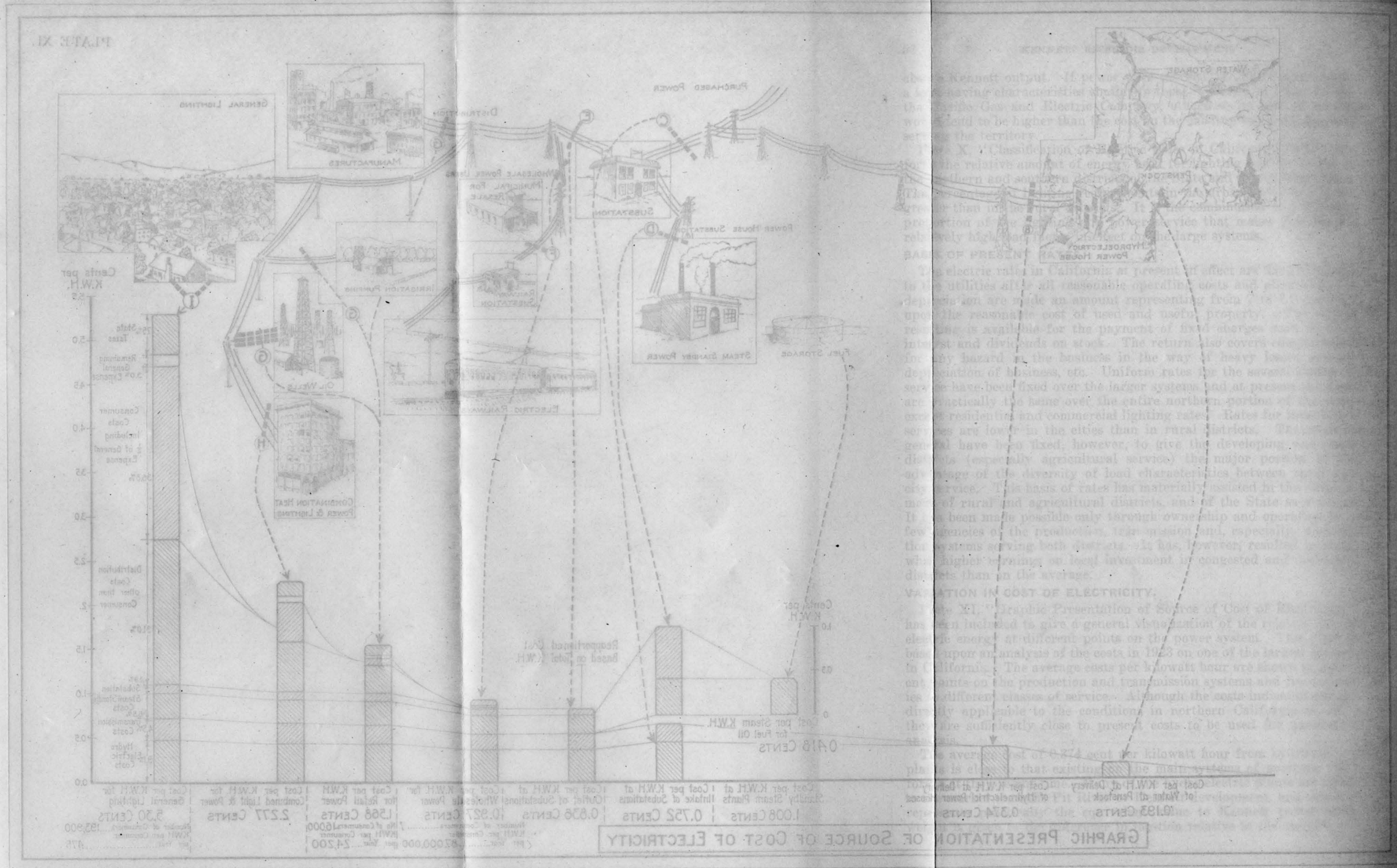


PLATE XI.
GRAPHIC PRESENTATION OF SOURCE OF COST OF ELECTRICITY
Cost per K.W.H. for General Lighting 5.50 CENTS
Cost per K.W.H. for Combined Light & Power 2.277 CENTS
Cost per K.W.H. for Retail Power 1.568 CENTS
Cost per K.W.H. for Wholesale Power 0.927 CENTS
Cost per K.W.H. at Outlet of Substations 0.836 CENTS
Cost per K.W.H. at Intake of Substations 0.752 CENTS
Cost per K.W.H. at Standby Steam Plants 1.008 CENTS
Cost per K.W.H. at Delivery of Hydroelectric Power House 0.374 CENTS
Cost per K.W.H. at Delivery of Water at Penstock 0.183 CENTS
Cost per Steam K.W.H. for Fuel Oil 0.418 CENTS

In this plate, the steam-electric standby service has been assumed to be delivered after secondary transmission and just prior to delivery to the distribution substation. The figure of 0.752 cent per kilowatt hour, cost at intake of substation, is therefore not camparable to the value of approximately five mills per kilowatt hour heretofore set forth for delivery at the terminal of the main transmission line near Antioch. The larger figure is due to the cost of extensive secondary transmission systems. The average of 0.836 cent per kilowatt hour represents the average cost of the combined hydro-electric and steam-electric power delivered from the secondary transmission or distribution substations. Beyond this point, the average costs are shown for wholesale power delivery to large industries, and resale to private and municipal companies and retail delivery to general power consumers and to the residential and commercial lighting consumers.

Study of the rates fixed by the Railroad Commission for the various classes of service indicates that the resultant average revenues from the several classes of services agree fairly closely with the average costs as indicated in Plate XI.

PROBLEMS INVOLVED IN PLAN 5.

Table 14, heretofore referred to, indicates that complete utilization of the Kennett output would require the development, measured at main transmission terminals, of a load of 1,275,000,000 kilowatt hours annually, or 26 per cent of the total estimated load for the entire tributary market in 1936.

From consideration of the characteristics of the power requirements of urban and rural territory, it is apparent that to distribute the output of the plant readily and economically will require a market to be developed having a balanced percentage of both urban and rural service.

There are only two means of developing a market for the output of the plant under this plan:

1. Competition with and duplication of existing systems.
2. Condemnation of sufficient of the existing agencies' systems, either directly by the State or by political subdivisions to make such a market available.

COMPETITION WITH AND DUPLICATION OF EXISTING SYSTEMS.

Competition would involve duplication of facilities, both in rural and urban districts, over a considerable portion of the entire northern part of the State in order to obtain a balanced market. Separately, neither rural nor urban districts would furnish a market that could readily absorb the output. On the basis of a division of the load in the competitive field equally between existing agencies and the State, the competition would have to be extended over nearly half of the market.

The procedure of obtaining a market by competition with a duplication of existing systems with its economic losses, is so far from being economically sound that it should not be given any further consideration.

CONDEMNATION OF EXISTING SYSTEMS.

Service of power load independently of existing agencies by condemnation or duplication of parts of their systems will require a greater expenditure for production and transmission capital than in the case

of the wholesaling of power as heretofore estimated. Kennett development, being located some 200 miles from the general market, would require additional transmission circuits and primary substations if operated independently of the existing systems and steam-electric standby capacity somewhat in excess of that indicated for comparative purposes in Table 14. In addition, secondary transmission lines and distribution systems would be required. Analysis of costs under Plans 1, 2, 3 and 4 has been based upon operating the plant as a part of a large coordinated system under which conditions the minimum of transmission capital would be required. The approximate capital investment for production, trunk transmission and steam-electric standby to serve the entire output of the plant, as estimated in Table 14, would have to be increased to at least the following:

Kennett reservoir and plant	$70,000,000
Main transmission line to terminal substations, three circuits	10,000,000
Substations	5,000,000
Steam-electric plant capacity for standby, 100,000 kilowatts	11,000,000
Total	$96,000,000

This does not include any amount for secondary transmission and distribution. The cost of secondary transmission and distributing systems necessary to market the load will depend upon what portions of the territory the State would choose to serve; the price that would have to be paid for the existing systems for both tangible properties and intangible values and severance damages; and the length of time required to purchase the systems.

Delays in obtaining a market could be expected, for condemnation proceedings at the best are slow. There is, therefore, a probability that the necessary distribution systems serving a sufficient market would not be available upon the completion of Kennett development. It is also doubtful whether certain districts would favor State ownership and operation as against local operation or a continuation of private service under regulation. A considerable development period, therefore, could be expected.

There are no criteria for estimating the prices that would have to be paid for secondary transmission and distribution systems and business of the existing utilities. Some indication of the cost may be obtained, however, from analysis of the cost of the physical property of existing systems. Study of the valuation of these properties indicates that the cost of secondary transmission and distribution systems in urban districts averages approximately $90 per thousand kilowatt hours of annual output of main substations. For rural systems it averages from $50 to $60, and for the combination as represented by the larger ultilities, approximately $65 per thousand kilowatt hours per annum of main substation output. On the basis of an average of $65 per thousand kilowatt hours annual delivery, capital expenditure for the physical plant required for distribution of Kennett power would be between $80,000,000 and $85,000,000. This, added to the cost of Kennett development, including trunk transmission lines and steam auxiliary plant, would make a total of approximately $180,000,000. To this would have to be added payments for going concern value and severance damages.

It is readily apparent that if the State were to go as far into the ownership and operation of distribution systems as would be necessary

to load a development such as Kennett, it would have to meet the growing demands of the territory being served. This would require continual outlay of capital for added power plants, transmission lines and distribution systems.

The minimum initial bond issue under Plan 5 would have to be not less than $200,000,000.

Disposition of power by wholesaling to municipalities for resale in urban districts and by State distribution in rural territory would not benefit the state as a producer of power beyond that under plans 3 or 4. Power sold to munipicalities would have to be at rates equal to or less than private utility rates to meet the competitive market. This, as has been indicated in discussing Plan 3a, would result in no benefits over plans 3 or 4. Distribution of power in rural districts would add no extra return to the State, for this service is rendered at the present time at rates justified only by the combination of distribution in both urban and rural districts.

POSSIBLE ECONOMIES UNDER PLAN 5.

The present utility rates are based on the utility as a whole making a reasonable return after operating expenses. No added economy in operating expenses could be expected under State ownership and operation over private ownership, and, at least during the transition period until adequate State machinery had been perfected for taking over and operating such a large utility, there would be a tendency for even higher operating costs. Taxes which might be eliminated in the case of State ownership would represent no actual saving to the State except possibly as a temporary condition in the case of federal tax, as the income to the State from taxes would be reduced by an amount equivalent to the reduction in operating costs of the electric system resulting from elimination of taxes. The source of possible economy under State ownership is represented in the difference between the rate allowed the private companies for return and depreciation annuity and the comparable cost to the State. The cost to the State must include not only the actual payment for interest and depreciation annuity but also the cost of contingencies and hazards, which is covered in the return allowed the private companies. These hazards and contingencies may be classified as heavy losses due to earthquakes, floods, extensive failures of structures, the general obsolescence of the service as a whole and periods of economic depression.

The cost of these hazards is not subject to any exact determination. Rates of return allowed private companies are in some cases as much as 1 per cent above the theoretical cost of money. Many of the steam and electric railroads have experienced an obsolescence of service that has made impossible an earning much in excess of the operating expenses of the properties. This same condition might occur in the case of power systems. The return over theoretical cost and obsolescence of service of other utilities can be considered only as indicative of the possible extent of hazards.

The apparent differential, as indicated by the comparison of rate of return, on the one hand and rate of interest, on the other is considerably in excess of the net differential. Differences in depreciation rates

will reduce the differential approximately 0.6 per cent. It is doubtful whether the net differential in rate would equal 1.5 per cent per annum as applied to the problem herein considered.

The differential in the case of complete State distribution of power from Kennett development would be largely offset by the fixed charges on the extra cost over the rate base for private utilities which would probably be incurred in connection with development of a market and the payment for severance damages and intangibles.

If distribution in urban districts were not handled by the State but confined to rural districts, the differential would be applicable to secondary transmission and rural distribution capital. In this case little or no saving would be actually available on account of the relatively low present rates in effect in rural districts.

It is doubtful if Plan 5 would assist sufficiently in carrying Kennett development to justify the added capital expenditures and service obligations that would be required of the State.

LIST OF POWER PLANTS IN CALIFORNIA, 1927. DELINEATED ON PLATE I

Group	*System*	*Company and plant*	*Classification*	*Index number*
Northern	I	CALIFORNIA OREGON POWER CO.		
		Fall Creek	Hydro-electric	1
		Copco No. 1	Hydro-electric	2
		Copco No. 2	Hydro-electric	3
		Shasta River	Hydro-electric	4
		Headlight	Hydro-electric	5
Northern	I	PACIFIC GAS AND ELECTRIC CO. AND ITS SUBSIDIARY COMPANIES		
		Pit No. 1	Hydro-electric	6
		Pit No. 3	Hydro-electric	7
		Hat Creek No. 1	Hydro-electric	8
		Hat Creek No. 2	Hydro-electric	9
		Eureka	Steam-electric	10
		Junction City	Hydro-electric	11
		Kilarc	Hydro-electric	12
		Cow Creek	Hydro-electric	13
		Volta	Hydro-electric	14
		Coleman	Hydro-electric	15
		Inskip	Hydro-electric	16
		South	Hydro-electric	17
		De Sabla	Hydro-electric	18
		Centerville	Hydro-electric	19
		Lime Saddle	Hydro-electric	20
		Coal Canyon	Hydro-electric	21
		Bullards Bar	Hydro-electric	22
		Colgate	Hydro-electric	23
		Spaulding No. 1 and No. 2	Hydro-electric	24
		Deer Creek	Hydro-electric	25
		Drum	Hydro-electric	26
		Alta	Hydro-electric	27
		Halsey	Hydro-electric	28
		Wise	Hydro-electric	29
		El Dorado	Hydro-electric	30
		American River	Hydro-electric	31
		Folsom	Hydro-electric	32
		Sacramento, Station "B"	Steam-electric	33
		Electra	Hydro-electric	34
		Spring Gap	Hydro-electric	35
		Stanislaus	Hydro-electric	36
		Phoenix	Hydro-electric	37
		Melones	Hydro-electric	38
		Stockton	Steam-electric	39
		North Beach	Steam-electric	40
		San Francisco, Station "A"	Steam-electric	41
		Oakland, Station "C"	Steam-electric	42
		Monterey	Steam-electric	43
Northern	I	CITY OF SAN FRANCISCO		
		Cherry Creek	Hydro-electric	44
		Moccasin Creek	Hydro-electric	45
Northern	I	SNOW MOUNTAIN WATER AND POWER CO.		
		Potter Valley	Hydro-electric	46
Northern	I	UTICA MINING CO.		
		Murphy	Hydro-electric	47
		Angels	Hydro-electric	48
Northern	I	COAST COUNTIES GAS AND ELECTRIC CO.		
		Big Creek (Swanton)	Hydro-electric	49
		Santa Cruz	Steam-electric	50
Northern	I	SOUTH SAN JOAQUIN AND OAKDALE IRRIGATION DISTRICTS		
		Melones Mine	Hydro-electric	51
Northern	I	WEST SIDE LUMBER CO.		
		Tuolumne	Steam-electric	52
Northern	I	TRUCKEE RIVER POWER CO.		
		Farad	Hydro-electric	53
Northern	II–a	GREAT WESTERN POWER CO. OF CALIFORNIA		
		Caribou	Hydro-electric	54
		Bucks Creek	Hydro-electric	55
		Las Plumas	Hydro-electric	56
		North Beach	Steam-electric	57
		Phelan	Steam-electric	58
		Bush	Steam-electric	59
		Oakland	Steam-electric	60

Group	System	Company and plant	Classification	Index number
Southern	II–b	SAN JOAQUIN LIGHT AND POWER CORPORATION		
		Kittridge	Hydro-electric	61
		Mountain King	Hydro-electric	62
		Merced Falls	Hydro-electric	63
		Crane Valley	Hydro-electric	64
		San Joaquin No. 1	Hydro-electric	65
		San Joaquin No. 1–A	Hydro-electric	66
		San Joaquin No. 2	Hydro-electric	67
		San Joaquin No. 3	Hydro-electric	68
		Kerckhoff	Hydro-electric	69
		Balch	Hydro-electric	70
		Tule River	Hydro-electric	71
		Kern Canyon	Hydro-electric	72
		Bakersfield	Steam-electric	73
		Midway	Steam-electric	74
		Betteravia	Steam-electric	75
Southern	II–b	MERCED IRRIGATION DISTRICT		
		Exchequer	Hydro-electric	76
Southern	II–b	TURLOCK AND MODESTO IRRIGATION DISTRICTS		
		Don Pedro	Hydro-electric	77
		La Grange	Hydro-electric	78
		Modesto	Steam-electric	79
Southern	II–b	UNITED STATES NATIONAL PARK SERVICE		
		Yosemite Park	Hydro-electric	80
Southern	III	SOUTHERN CALIFORNIA EDISON CO.		
		Big Creek No. 1	Hydro-electric	81
		Big Creek No. 2	Hydro-electric	82
		Big Creek No. 2–A	Hydro-electric	83
		Big Creek No. 3	Hydro-electric	84
		Big Creek No. 8	Hydro-electric	85
		Kaweah No. 1	Hydro-electric	86
		Kaweah No. 2	Hydro-electric	87
		Kaweah No. 3	Hydro-electric	88
		Visalia	Steam-electric	89
		Tule River	Hydro-electric	90
		Kern River No. 3	Hydro-electric	91
		Borel	Hydro-electric	92
		Kern River No. 1	Hydro-electric	93
		Azusa	Hydro-electric	94
		Sierra	Hydro-electric	95
		Lytle Creek	Hydro-electric	96
		Fontana	Hydro-electric	97
		Santa Ana No. 1	Hydro-electric	98
		Santa Ana No. 2	Hydro-electric	99
		Santa Ana No. 3	Hydro-electric	100
		Mill Creek No. 1	Hydro-electric	101
		Mill Creek No. 2–3	Hydro-electric	102
		Redondo	Steam-electric	103
		Long Beach	Steam-electric	104
		San Antonio Creek No. 1	Hydro-electric	105
		San Antonio Creek No. 2	Hydro-electric	106
		San Antonio Creek No. 3	Hydro-electric	107
Southern	III	CITY OF LOS ANGELES		
		Big Pine No. 3	Hydro-electric	108
		Division Creek No. 1	Hydro-electric	109
		Division Creek No. 2	Hydro-electric	110
		Cottonwood No. 1	Hydro-electric	111
		Haiwee	Hydro-electric	112
		San Francisquito No. 1	Hydro-electric	113
		San Francisquito No. 2	Hydro-electric	114
		San Fernando	Hydro-electric	115
		River Power	Hydro-electric	116
		Franklin Canyon	Hydro-electric	117
Southern	III	CITY OF PASADENA		
		Pasadena	Steam-electric	118
Southern	IV	LOS ANGELES GAS AND ELECTRIC CORPORATION		
		Alameda Street	Steam-electric	119
		Seal Beach	Steam-electric	120
Southern	IV	SOUTHERN SIERRAS POWER CO.		
		Mill Creek	Hydro-electric	121
		Poole (Leevining Creek No. 1)	Hydro-electric	122
		Leevining Creek No. 3	Hydro-electric	123
		Rush Creek	Hydro-electric	124
		Adams auxiliary	Hydro-electric	125
		Adams main	Hydro-electric	126
		Bishop Creek No. 2	Hydro-electric	127
		Bishop Creek No. 3	Hydro-electric	128

Group	System	Company and plant	Classification	Index number
Southern	IV	SOUTHERN SIERRAS POWER CO.—Continued.		
		Bishop Creek No. 4	Hydro-electric	129
		Bishop Creep No. 5	Hydro-electric	130
		Bishop Creek No. 6	Hydro-electric	131
		San Bernardino	Steam-electric	132
		San Gorgonio No. 1	Hydro-electric	133
		San Gorgonio No. 2	Hydro-electric	134
		Blythe	Gas-electric	135
		El Centro	Steam-electric	136
Southern	IV	SAN DIEGO CONSOLIDATED GAS AND ELECTRIC CO.		
		Station "A"	Steam-electric	137
		Station "B"	Steam-electric	138
Southern	IV	ESCONDIDO MUTUAL WATER CO.		
		Rincon	Hydro-electric	139
		Bear Valley	Hydro-electric	140
Southern	IV	UNITED STATES RECLAMATION SERVICE		
		Yuma	Hydro-electric	141

LIST OF SUBSTATIONS. DELINEATED ON PLATE I

Group	System	Company and substation	Index letters
Northern	I	PACIFIC GAS AND ELECTRIC CO.	
		Vaca-Dixon	A
		Contra Costa	B
		Newark	C
Northern	II–a	GREAT WESTERN POWER CO. OF CALIFORNIA	
		Antioch	D
		Golden Gate	E
		Brighton	F
Southern	II–b	SAN JOAQUIN LIGHT AND POWER CORPORATION	
		Wilson	G
Southern	III	SOUTHERN CALIFORNIA EDISON CO.	
		Vestal	H
		Eagle Rock	I
		Laguna Bell	J
		Lighthipe	K

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PUBLICATIONS OF THE DEPARTMENT OF PUBLIC WORKS
DIVISION OF ENGINEERING AND IRRIGATION

Bulletin No. 1—California Irrigation District Laws, 1921 (Obsolete).
*Bulletin No. 2—Formation of Irrigation Districts, Issuance of Bonds by Irrigation Districts, Expenditure of Construction Funds, etc.
Bulletin No. 3—Water Resources of Tulare County and Their Utilization, 1922.
Bulletin No. 4—Water Resources of California.
Bulletin No. 5—Flow in California Streams.
Bulletin No. 6—Irrigation Requirements of California Lands.
Bulletin No. 7—California Irrigation District Laws, 1923 (Obsolete).
*Bulletin No. 8—Cost of Water to Irrigators in California.
Bulletin No. 9—Supplemental Report on Water Resources of California.
Bulletin No. 10—California Irrigation District Laws, 1925 (Obsolete).
Bulletin No. 11—Ground Water Resources of the Southern San Joaquin Valley.
Bulletin No. 12—Summary Report on the Water Resources of California and a Coordinated plan for Their Development.
Bulletin No. 13—The Development of the Upper Sacramento River.
Bulletin No. 14—The Control of Floods by Reservoirs.
Bulletin No. 18—California Irrigation District Laws, 1927.
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*Bulletin No. 5—Report on the Utilization of Mojave River for Irrigation in Victor Valley, California, 1918 (v).
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Bulletin No. 7—Use of Water from Kings River, California, 1918.
*Bulletin No. 8—Flood Problems of the Calaveras River, 1919.
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*Second Biennial Report, 1908–1910, Department of Engineering.
*Third Biennial Report, 1910–1912, Department of Engineering.
*Fourth Biennial Report, 1912–1914, Department of Engineering.
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*Sixth Biennial Report, 1916–1918, Department of Engineering.
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*Report—State Water Problems Conference, November 25, 1916.
*Report on Pit River Basin, April, 1915.
*Report on Lower Pit River Project, July, 1915.
*Report on Iron Canyon Project, 1914.
*Report on Iron Canyon Project, California, May, 1920.

(†) Reprinted in 5th Biennial Report. (Out of print.)
(II) Reprinted in 5th Biennial Report. (Out of print.)
(v) Reprinted in 6th Biennial Report. (Out of print.)

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*Reports and Bulletins out of print, may be borrowed by your local library from the California State Library at Sacramento, California.